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A Distributional Analysis and Identification Key for Crayfishes (Decapoda: Cambaridae) of the Clinch and Powell River Systems, Virginia

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INTRODUCTION

Most of the aquatic vertebrate taxa in southwestern Virginia have been extensively sampled and reported in the literature. The fishes were covered by Jenkins & Burkhead (1994) and Masnick (1974), the amphibians by Tobey (1985), and the reptiles by Mitchell (1994). However, among the invertebrate groups, only mollusks (mussels, snails) have received considerable attention (Neves et al., 1980; Ahlstedt, 1986; Ahlstedt, 1991). There has been no concerted effort to sample the crayfishes, which are an ecologically important group of invertebrates. Consequently, little is known of crayfish distribution, abundance, and natural history in this area. There is no regional key to the crayfishes, but experts such as the late H. H. Hobbs, Jr., R. W. Bouchard, and others have acknowledged the importance of the upper Tennessee River and the likely occurrence within its basin of rare or new species. The high diversity, relative to other regions, known for aquatic vertebrates and mollusks should apply to crayfishes as well. It is important, therefore, to catalog the crayfish species of this region, describe their distributions, and assess threats to their continued existence.

Crayfishes are considered to be keystone species in many of the ecosystems they inhabit, and function as important predators and prey in many faunal assemblages (DiStefano, 1993; Hobbs, 1993; Momot, 1995). In streams and rivers, they are prey to most gamefish species, converting autochthonous and allochthonous organic matter to usable nutrients and energy for vertebrate predators. In the Powell River, Virginia, for example, crayfishes are the dominant food items in diets of adult *Ambloplites rupestris* (rock bass) and *Micropterus dolomieu* (smallmouth bass), and crayfish abundance has been correlated with the abundance and condition of both of these species (Cummins, 1994). Maintaining crayfish populations may be essential to sustaining recreational fishing in this region.

The goals of this study were to 1) document geographic distributions of crayfishes in the Clinch and Powell river systems in Virginia, and 2) construct a key to the crayfishes of this region based on external structure for use by state natural resource managers and amateur naturalists.

MATERIALS AND METHODS

Study Area

The Clinch and Powell rivers, major tributaries to the upper Tennessee River, flow roughly parallel and join at Norris Lake about 20 km south of the Virginia/Tennessee line (Fig. 1). Their catchments span two physiographic provinces, the Valley and Ridge to the southeast and the Cumberland Plateau to the northwest

(Fig. 1). Both rivers are 6th-order when they cross the state line. They feature well-developed, pool-riffle fluvial morphology.

Qualitative Sampling

Crayfishes were sampled at 109 sites from summer 1992 to spring 1996 (Fig. 1). Exact location data for each site are available in Winston et al. (1996). Sample sites were located in a variety of lotic systems, from river mainstems to 1st-order tributaries and springs, including many of the largest springs in the region (Collins, 1930). Sampling methods, seasons, and personnel varied during the project. Collection effort was not standardized, nor do we know how much effort would be required to collect all species in an area. Sufficient effort to collect common species at a site was based on the experience of the principal collector (P. S. Lookabaugh or M. R. Winston). In summer 1992, P. S. Lookabaugh and assistants sampled 35 sites by electroshocking. During the summers of 1993 and 1994, P. S. Lookabaugh and an assistant sampled 48 sites using a handheld net while snorkeling, or by excavating bankside burrows. During fall 1995 and spring 1996, 26 sites were sampled, mostly by M. R. Winston and an assistant. Riverbank burrows were excavated, whereas streams were sampled by lifting rocks and chasing crayfishes into a seine. Most preserved crayfishes from these surveys were deposited with the Virginia Museum of Natural History in Martinsville; reference specimens were kept at the Department of Fisheries and Wildlife Sciences, VPI&SU, in Blacksburg.

Identification of Species

Voucher specimens were identified by Dr. R. W. Bouchard, Philadelphia Academy of Natural Sciences. These identifications, along with extant keys and descriptions (Hobbs, 1972, 1981, 1989; Hobbs & Bouchard, 1994; Jezerinac et al., 1995), were used to construct a key for identification of crayfish species in the Clinch and Powell river systems.

Subgeneric categories used in this study were based on Hobbs (1989) and Fitzpatrick (1987). The monophyly of the genus *Orconectes* and Fitzpatrick's subgeneric designations based on morphological characters have recently been questioned by molecular evidence (Crandall

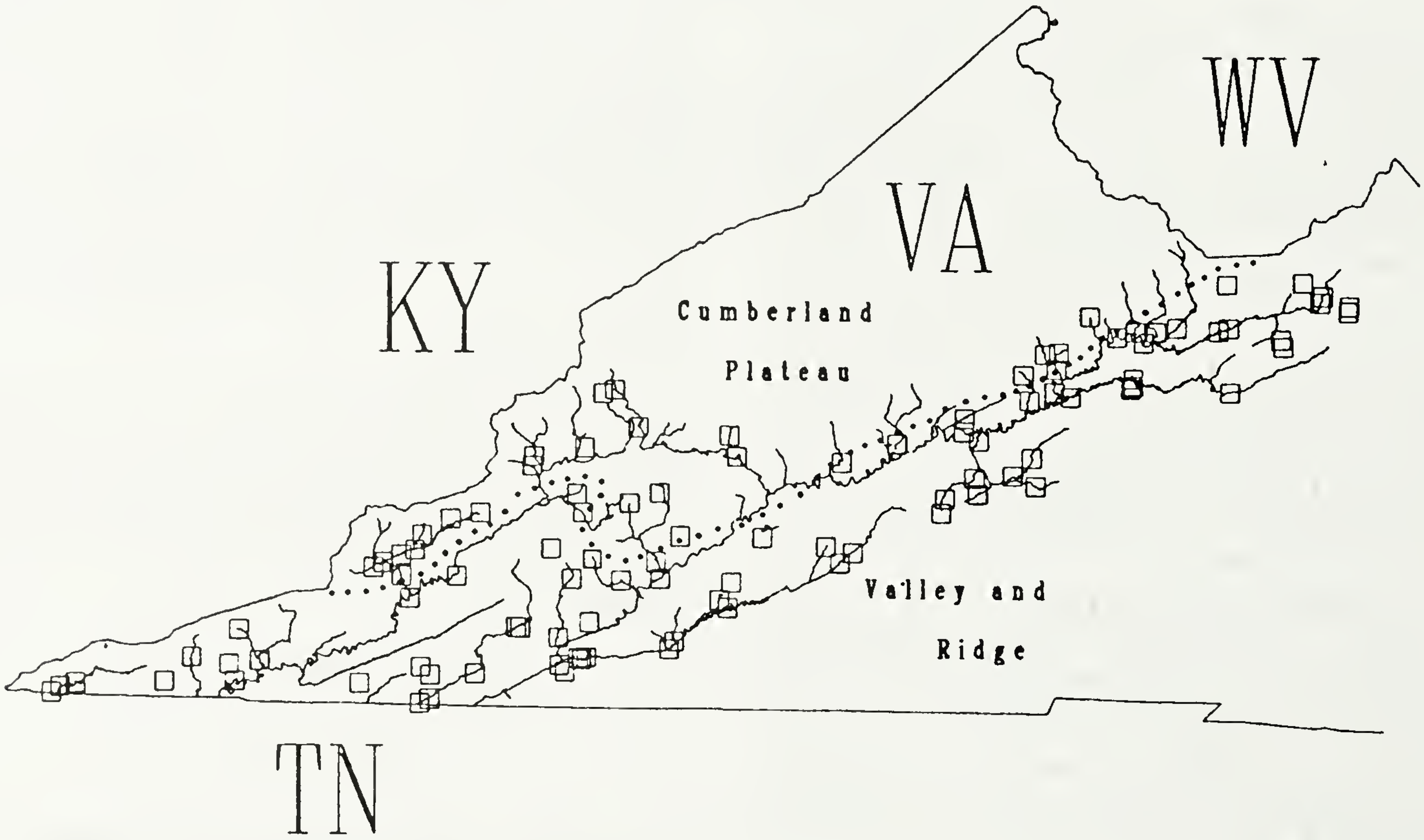

Fig. 1. The 109 sites sampled for crayfishes during this study. Only 4th-order or larger streams of the Clinch and Powell river systems in southwest Virginia are shown. The dotted line shows the approximate boundary between the Valley and Ridge and Cumberland Plateau physiographic provinces.

& Fitzpatrick, 1996; Fetzner, 1996). However, because no alternative classification has been offered, Fitzpatrick's system is used here.

RESULTS

Species Accounts

Nine species were collected at the 109 sites sampled in the Clinch and Powell systems in Virginia. An additional species was collected in the Clinch system just across the state line in Tennessee (see below). None of these species was considered rare by Taylor et al. (1996). A maximum of three species was collected together in streams and two species in burrows. Crayfish were present in all permanent waters. A key for identifying these species is provided in Table 1; a glossary of terms used in the text and the key is provided in Table 2.

Cambarus (Cambarus) angularis Hobbs & Bouchard

This species, endemic to the Clinch, Powell, and Holston systems, was described recently by Hobbs & Bouchard (1994). We collected it throughout the Clinch and Powell systems (Fig. 2), in small and large streams, at high and low elevations, and in both physiographic provinces. It was most readily collected in medium to small streams, and was the only species found in small headwater streams and springs. Its color ranged from reddish-brown in Valley and Ridge populations to yellowish-brown in Cumberland Plateau populations.

Most collections made from 1992 to 1994 contained only Form-II males, but the *Cambarus* (*Cambarus*) specimens were still identifiable as *C. angularis* because they had thickened rostral margins. There were some sites, however, where Form-II males did not show thickened rostral margins. Since these could have been *C. bartonii*, these sites were resampled in the fall and spring. All male *Cambarus* (*Cambarus*) collected were Form-I *C. angularis*.

Cambarus (Cambarus) bartonii cavatus Hay

This species was collected at only one site (Fig. 2). The Form-I male collected there was readily differentiated from *C. angularis* by a narrow areola and the lack of thickened rostral margins. The Form-II male collected was identified as *C. bartonii cavatus* rather than *C. angularis* because it, like the Form-I male, was collected from a burrow and had a narrow areola. *Cambarus angularis* always has a wide areola and has never been collected from burrows (personal observation; Hobbs & Bouchard, 1994).

Cambarus bartonii cavatus may be more widespread than indicated by our one collection. Finding and sampling crayfishes that live in burrows is time-intensive, which usually makes for small sample sizes. The presence of such species may go undetected unless concerted effort is made to collect them.

Cambarus (Jugicambarus) dubius Faxon

This species was collected from burrows throughout the Clinch and Powell systems, including the site where we found *C. bartonii cavatus* (Fig. 3). We collected two color types: one had a bright blue body and orange-tipped fingers on the chelae; the other had an orange body and chelae. This species was relatively easy to collect in marshy areas and at the edges of very small streams with low banks. We collected several from the edges of larger streams, but this was more difficult because of the greater depths of the burrows.

Cambarus (Jugicambarus) parvoculus Hobbs & Shoup

This species was collected only in the mainstem of the North Fork Powell River (Fig. 3), where it was uncommon. The population is at the extreme edge of the species range (Hobbs & Shoup, 1947; Hobbs, 1969). Most individuals collected were brown, but some had a light blue tinge. The best way to differentiate this species from *C. dubius* is to examine the gonopods of Form-I males. Although *C. parvoculus* is found in rocky streams and *C. dubius* generally in burrows, the latter is also sometimes found in rocky streams (Jezerinac et al., 1995).

Cambarus (Hiaticambarus) longirostris Faxon

This species was collected throughout the Valley and Ridge province, but only once from the Cumberland Plateau (Fig. 4). The specimen from the Cumberland Plateau was unusual in that it somewhat resembled the *C. angularis* with which it was found. We collected the greatest numbers of *C. longirostris* in riffles of the upper Clinch River, Copper Creek, and Little River. Individuals from Copper Creek were especially spectacular, with orange-red coloration, a black saddle pattern, pastel blue on the sides of the carapace, and large chelae (see James [1966] and Hobbs [1981] for further discussion of this species).

Cambarus (Puncticambarus) buntingi Bouchard

This species was temporarily named 'species D' by Hobbs (1969) and described by Bouchard (1973). Bouchard (1973), Hobbs (1989), and Taylor et al. (1996)

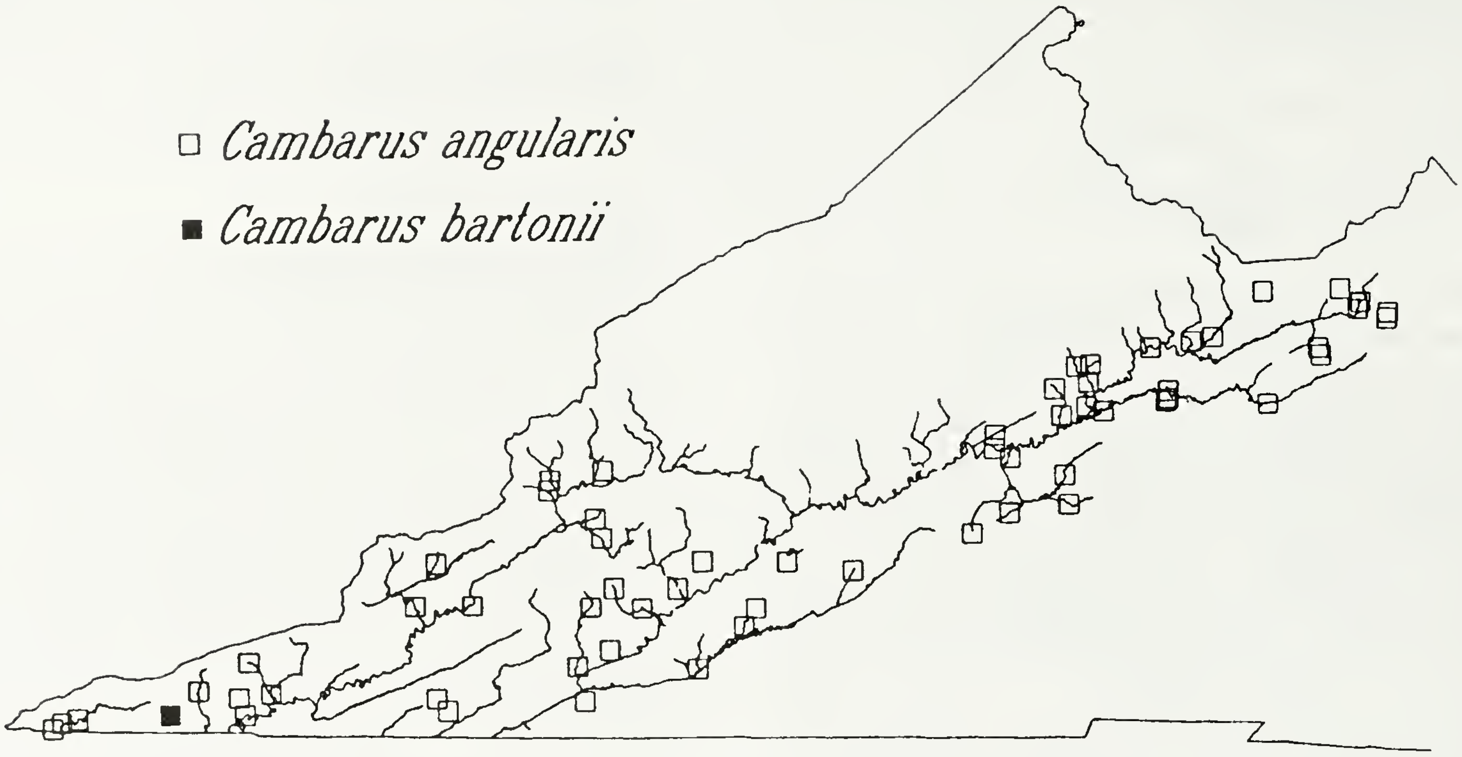

Fig. 2. C. (C.) *angularis* was found at 64 sites; C. (C.) *bartonii cavatus* was found at one site.

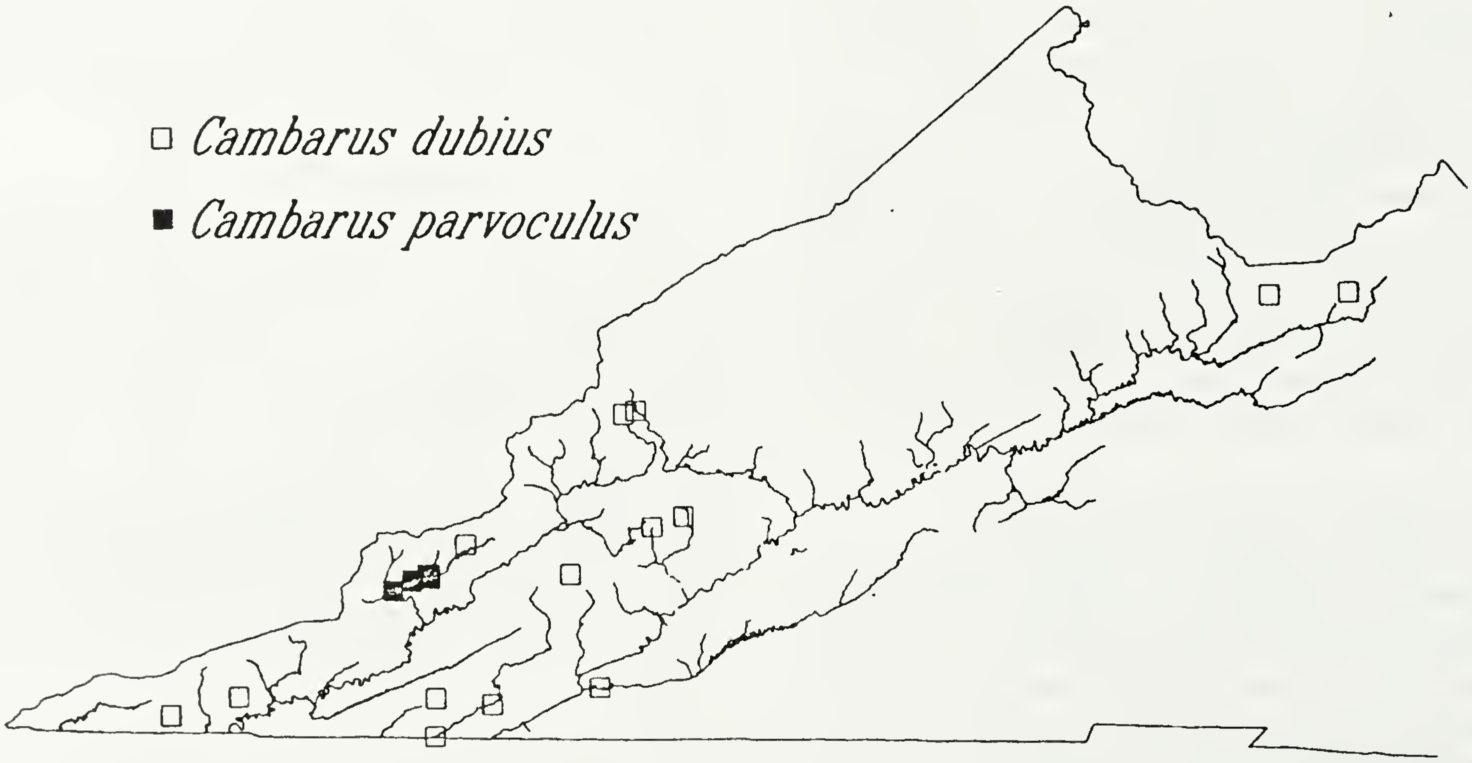

Fig. 3. C. (J.) *dubius* was found at 14 sites; C. (J.) *parvoculus* was found at three sites.

did not include it in the Virginia cambarid fauna, but Hobbs (1969) and Bouchard (1975b) indicated its presence in the state. We collected it only on the Cumberland Plateau, mainly from the North Fork Powell River and Guest River (Fig. 4), where it was common. Color was a distinctive green.

Orconectes (Crockerinus) erichsonianus (Faxon)

This species was collected only from Copper Creek, lower Clinch River, and North Fork Clinch River (Fig. 5), and was uncommon in these locations, which are at the northern edge of its range (Hobbs 1981; 1989). We collected it with *Orconectes (Procericambarus) forceps* (Faxon) but never with *Orconectes (Procericambarus) putnami* (Faxon). It is similar to O. *putnami* in general mien, and both species are bluish-green in color. The central projection of the gonopod (first pleopod) of Form-I males in our O. *erichsonianus* samples comprised about one-third of the total length of the appendage, which is at or near the upper extremes reported in the literature (Hobbs 1981; Fitzpatrick 1987).

Orconectes (Procericambarus) putnami (Faxon)

This species was common and widespread in the northern and higher elevation areas of the Clinch and Powell river systems, but was generally absent from the southern, low elevation sites (Fig. 5). This is the same species identified as O. *spinosus* in Jezerinac et al. (1995).

Orconectes (Procericambarus) forceps (Faxon)

This species was collected only in southern, low-elevation sites (Fig. 6), where abundance varied from rare to common. Large males were striking in appearance, with long chelae and widely gaping fingers. The mottled black pattern on a light brown background is reminiscent of the shadows made by sunlight shining through rippled water.

Orconectes (Procericambarus) rusticus (Girard)

This species was not found in Virginia, but was common in the Clinch River system in Tennessee, 20 km south of the Virginia line. Nineteen specimens were

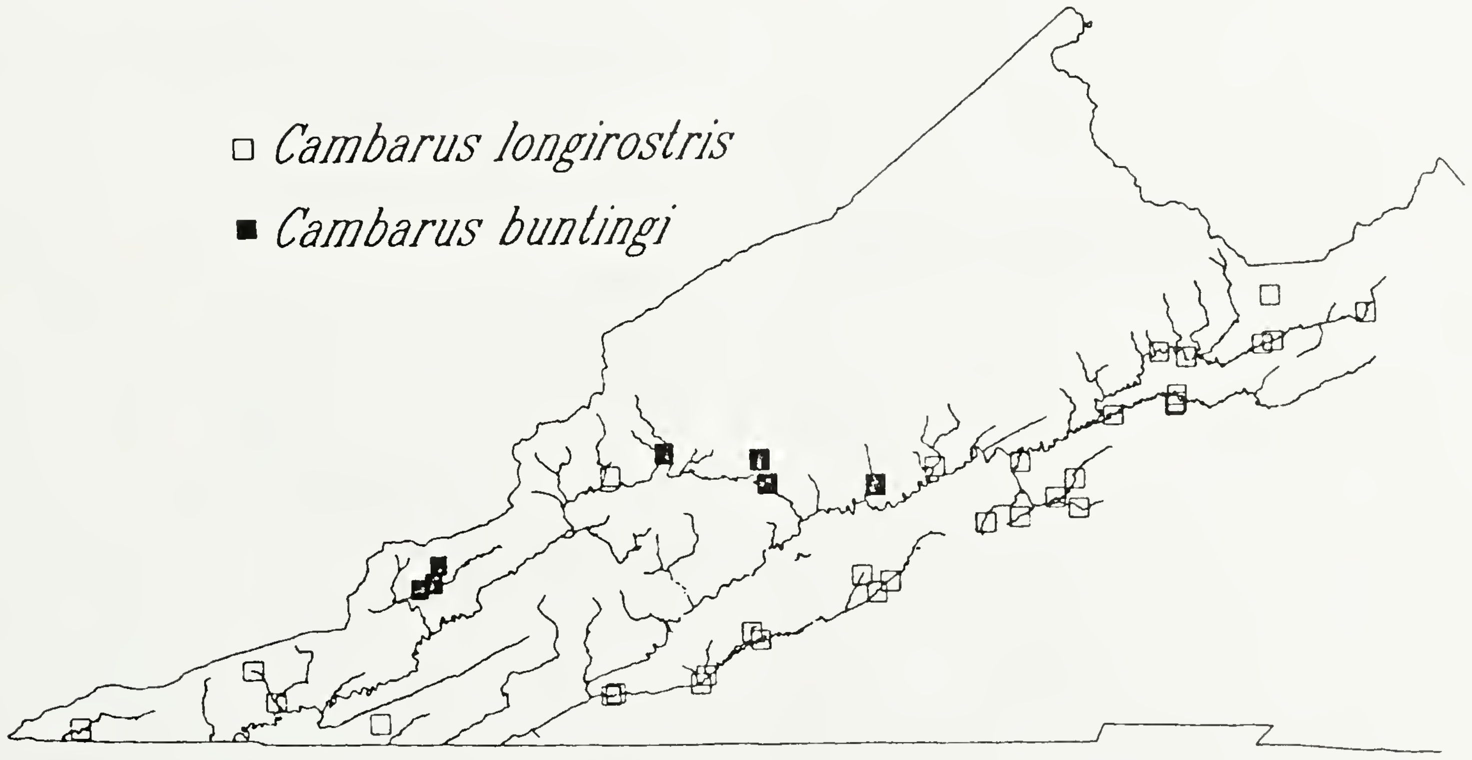

Fig. 4. C. *(H.) longirostris* was found at 34 sites; C. *(P.) buntingi* was found at seven sites.

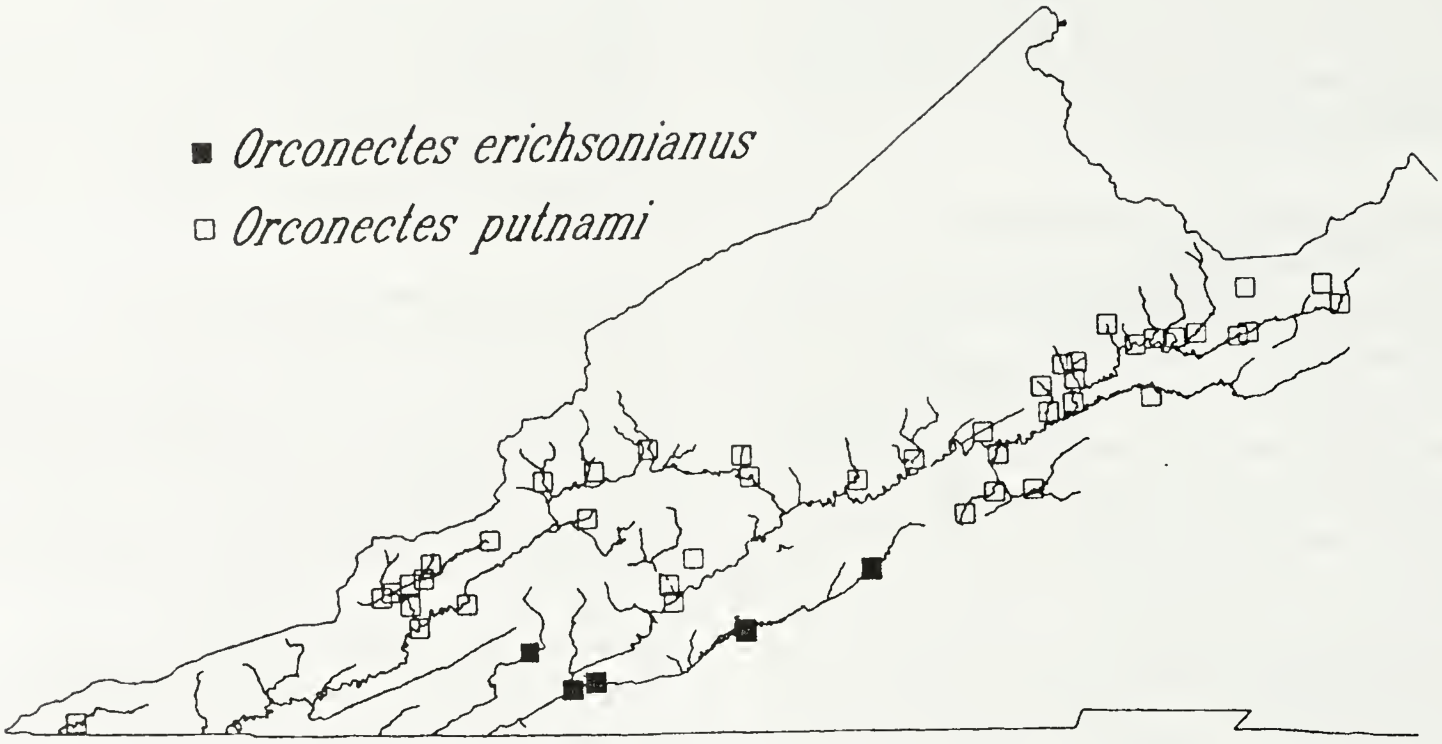

Fig. 5. O. (C.) *erichsonianus* was found at five sites; O. (*P.*) *putnami* was found at 47 sites.

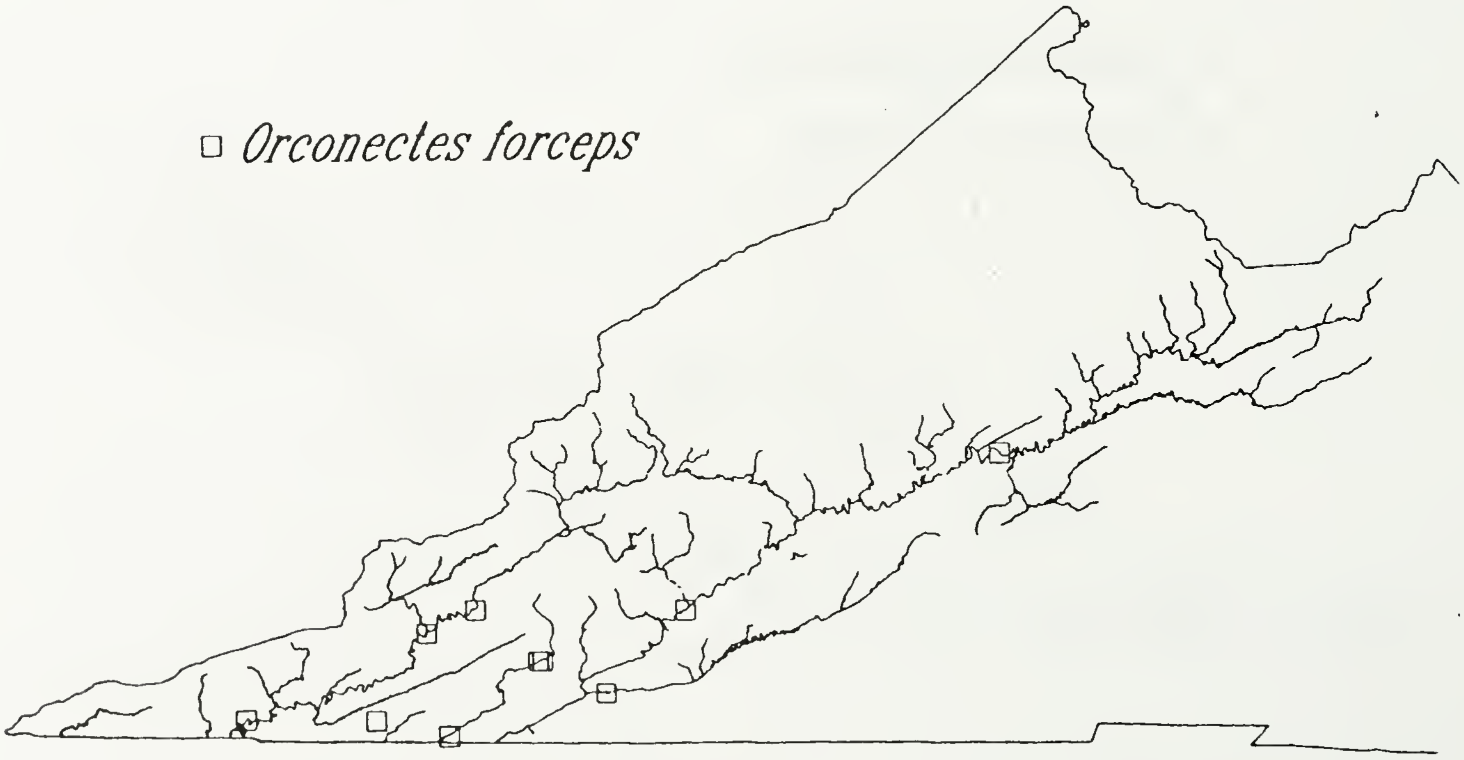

Fig. 6. O. (*P.*) *forceps* was found at ten sites.

collected, along with specimens of O. *forceps* and C. *longirostris*. They were collected while electrofishing on 25 August 1992, in Indian Creek, a tributary to Norris Reservoir, Grainger County, Tennessee. Three other streams in this area, Big War, Big Sycamore, and Swan creeks, also were sampled, but O. *rusticus* was not found. This species is not native to the upper Tennessee River (Bouchard, 1975a).

Distributional Patterns

The ten species of crayfishes collected in the Clinch and Powell river systems can be classified as ubiquitous, regionally restricted, or rare. *Cambarus angularis* and C. *dubius* were ubiquitous; i.e., they were collected throughout the systems. *Cambarus bartonii cavatus* and O. *rusticus* were rare; i.e., each was collected at only one site. The other six species were regionally restricted.

The, most widespread of the regionally restricted species, O. *putnami*, was collected throughout the northern two-thirds of the region, but only once in the southern one-third of the region (Fig. 5). Complementary to this were the distributions of O. *erichsonianus* and O. *forceps* which, with the exception of one northern occurrence of O. *forceps* in the mainstem Clinch River, were collected only in the southern one-third of the region (Figs. 5, 6). Streams from the southern one-third of the region are generally lower in elevation and channel slope than streams in the northern part of the region.

The second most widespread of the regionally restricted species, C. *longirostris*, was collected in many locations in the Valley and Ridge province but only once in the Cumberland Plateau (Fig. 4). Complementary to this were the distributions of C. *parvoculus* and C. *buntingi*, which were collected exclusively in the Cumberland Plateau (Figs. 3, 4). The three main tributaries in this region are the North Fork Powell River, the upper Powell River, and Guest River (Clinch tributary). *Cambarus parvoculus* was collected only in the North Fork Powell River (Fig. 3), whereas C. *buntingi* was collected there and in the Guest River (Fig. 4). Why neither species was collected in the upper Powell River, an area between the North Fork Powell River and the Guest River, is unclear. Further collecting, especially in the mainstem of the upper Powell River, may reveal that these species occur there as well.

Some stream-size associations were evident. *Cambarus angularis* was collected in all sizes of streams, but it was the only species collected in headwater streams and springs. *Cambarus longirostris* was the most commonly collected crayfish in riffles of medium-sized streams, but was not collected in the larger rivers (Fig. 4). The *Orconectes* species, however, were often collected in the mainstem rivers (Figs. 5, 6).

These patterns were similar to those seen for fishes of the region (Angermeier et al., 1996), which exhibited distributional associations with stream size, physiography, elevation, and channel slope. However, they differed in that the crayfishes seemed to be more regionally restricted. For example, no fishes were restricted to the Cumberland Plateau, unlike the pattern seen for C. *parvoculus* and C. *buntingi*. Similarly, the demarcation between northern and southern species was not as clear for fishes as for the pattern seen for O. *putnami* versus O. *erichsonianus* and O. *forceps*.

DISCUSSION

Threats and Conservation

Displacement of native species by introduced species seems to be a common occurrence with crayfishes (Schwartz et al., 1963; Rorer & Capelli, 1978; Hill & Lodge, 1994; Light et al., 1995; Soderback, 1995). One of these species proven to be invasive, O. *rusticus*, was documented before 1975 from Norris Reservoir at the confluence of the Clinch and Powell rivers (Bouchard, 1975a). Our data showed that it had not spread upstream, but the situation bears watching.

As part of any plan to conserve the present crayfish diversity in the Clinch and Powell river systems of Virginia, the two stream species with the most restricted distributions, C. *parvoculus* and O. *erichsonianus*, should be monitored. In Virginia, C. *parvoculus* seems to be restricted to the mainstem of the North Fork Powell River above Pennington Gap, and O. *erichsonianus* is restricted to Copper Creek and the North Fork Clinch River downstream of Duffield. A single toxic spill could eliminate the population of C. *parvoculus*. If O. *rusticus* were to expand its range and threaten to displace other species, O. *erichsonianus* might be the most vulnerable because of its low population numbers and the population's proximity to Norris Lake. *Orconectes erichsonianus* may also require good habitat quality, since it inhabits only those locations shown by Angermeier & Smogor (1993) to have high biotic integrity.

Need for Additional Surveys

Neither C. *buntingi* nor O. *putnami* were listed among the 22 native and two introduced species in the latest checklist for Virginia (Taylor et al., 1996). With the addition of these species, the nine species collected in the Clinch and Powell river systems in Virginia represent 34 percent of the 26 native species known from Virginia. The three forks of the Holston River (the other Tennessee River headwaters in Virginia) may support many of the same species; however, a systematic survey of this region will be required before species composition can be verified. Of the nine species reported herein, only *C. bartonii cavatus* and *C. dubius* are native to Virginia outside of the Tennessee River system. We recently collected *O. putnami* in Tom's Creek (New River drainage) near Blacksburg. This may be the introduced species called *Orconectes juvenilis* by Hobbs & Walton (1966) and *O. spinosus* by Rorer & Capelli (1978). The most comprehensive information on the crayfishes of the New River drainage in Virginia is 30 years old (Hobbs et al., 1967).

Many crayfish species, especially those in the same subgenus, are difficult to distinguish. As emphasized by Hobbs (1972), identification of these species often requires Form-I males. In the present study, we returned to the rivers in the fall and spring to collect Form-I males, in order to help identify the summer-collected Form-II males and females. This was the case for *C. angularis*/*C. bartonii cavatus*, *C. dubius*/*C. parvoculus*, and *O. erichsonianus*/*O. putnami*. For the two *Cambarus* pairs, even with specimens of Form-I males in hand, the Form-II males could not be identified with complete confidence. Therefore, in order to maximize cost-effectiveness and accuracy, future surveys for crayfishes in Virginia should be undertaken in the fall and spring whenever possible.

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TABLE 1. KEY TO THE CRAYFISHES OF THE CLINCH AND POWELL RIVER SYSTEMS, VIRGINIA.

This key is not designed for use with specimens in other river systems in Virginia. Rare, undescribed, or introduced species not covered here may occur in these river systems. Terms are defined either in the Figures or in the Glossary (Table 2).

Key to Genera and Species

1. Both terminal elements of gonopod curved caudally at 90 degrees or more to shaft axis (Fig. 9a): Genus *Cambarus* 2

   Both terminal elements of gonopod never bent at an angle as great as 90 degrees to shaft axis (Fig. 9b): Genus *Orconectes* 7

2. Tubercles on mesial margin of palm forming cristiform row (Fig. 10c); fingers relatively short: length of palm about two-thirds length of dactyl (Fig. 8) 3

   Tubercles on mesial margin of palm not forming cristiform row (Figs. 10a, b); fingers relatively long: length of palm usually much less than length of dactyl (Fig. 8) 4

3. Central projection of gonopod of Form-I male long and strongly recurved, extending proximally to distal margin of mesial process (Fig. 11a); inhabits rocky streamsC. *(Jugicambarus) parvoculus*

   Central projection of gonopod of Form-I male shorter, not extending proximally to distal margin of mesial process (Fig. 11b); usually found in burrows, rarely under rocks in streams .... C. *(J.) dubius*

4. Mesial margin of palm with 2 major rows of tubercles (Fig. 10a); rostrum acuminate (Fig. 12a).......... C. *(Puncticambarus) buntingi*

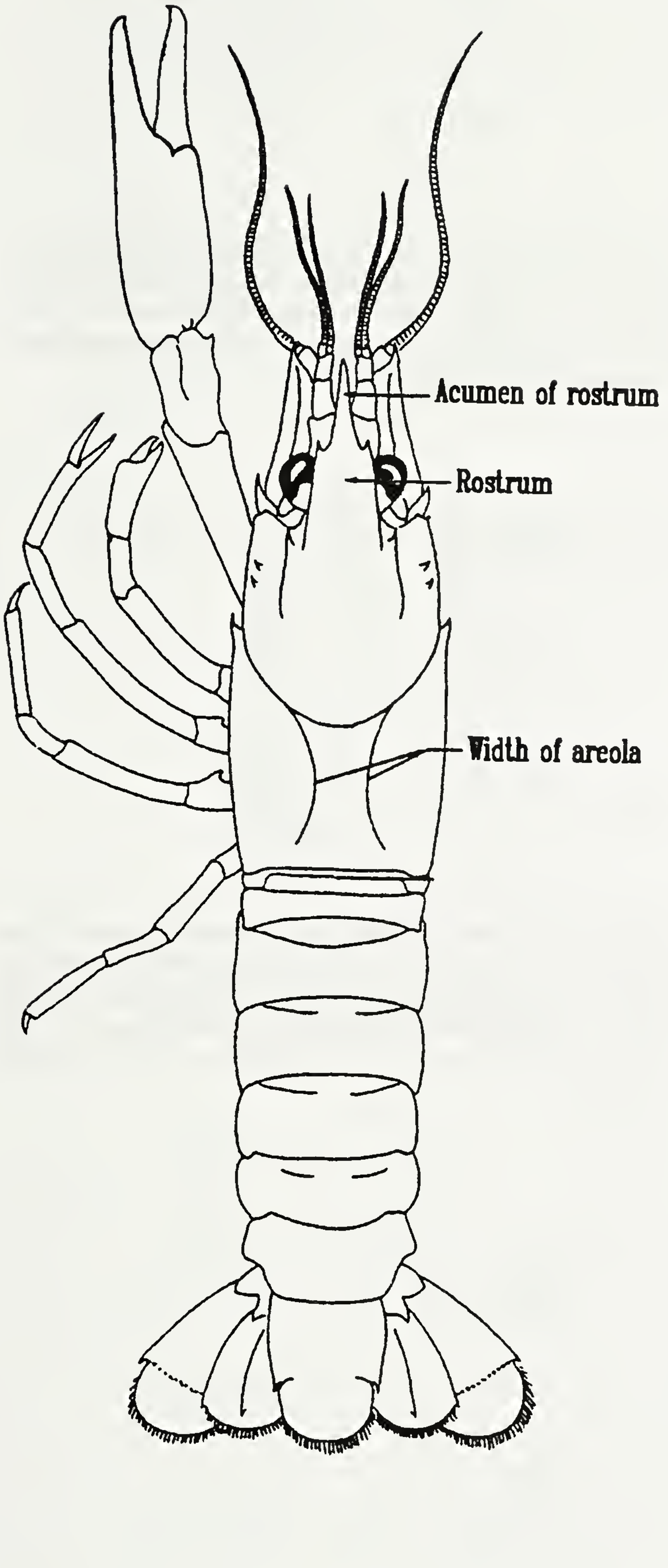
   Mesial margin of palm with single row of 3 to 6 tubercles, often indistinct, sometimes with second row of three or four small ones (Figs. 10b, c); rostrum usually with margins abruptly contracted at base of acumen (Figs. 12b-d) 5

5. Fingers of chela with extremely wide gape, with indistinct to moderately distinct longitudinal ridges dorsally; tuft of setae at base of opposable margin of fixed finger in all but large Form-I males (Fig. 10b); rostrum narrow with width less than two-thirds total length (Fig. 12d) .... C. *(Hiaticambarus) longirostris*

   Fingers of chela widely gaping only in some large individuals, and with distinct longitudinal ridges dorsally; no tuft of setae at base of opposable margin of fixed finger; rostrum broad with width greater than two-thirds total length (Figs. 12b, c) 6

6. Rostral margins of Form-I males thickened (Fig. 12c), those of Form-II males and females may or may not be thickened .... C. *(Cambarus) angularis*

   Rostral margins of Form-I males and females not thickened (Fig. 12b) .... C. *(C.) bartonii*



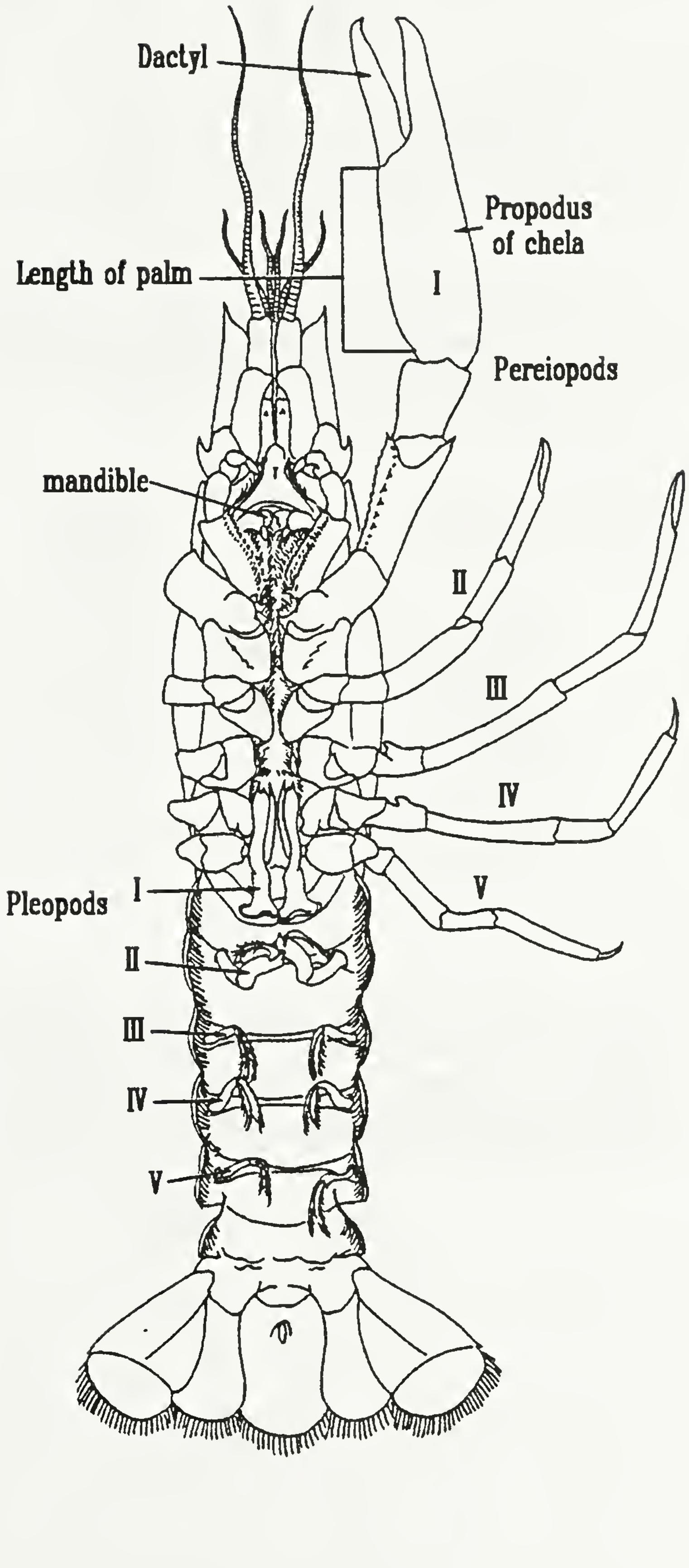


Fig. 7. Dorsal view of generalized male crayfish illustrating structures and measurements mentioned in the text and referenced in the key (modified from Hobbs, 1972).

Fig. 8. Ventral view of generalized male crayfish illustrating structures and measurements mentioned in the text and referenced in the key (modified from Hobbs, 1972).

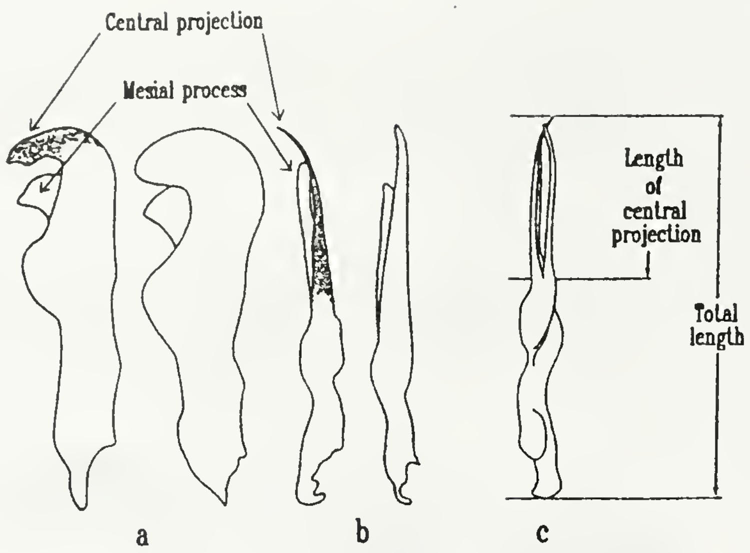


Fig.9. Left gonopods of *Cambarus* and *Orconectes* (from Hobbs, 1972). *a-b*, Lateral views of Form-I and Form-II males, corneous central projection shaded – *a*, *Cambarus*; *b*, *Orconectes*; *c*, Method of measuring gonopods (mesial view) in *Orconectes*.

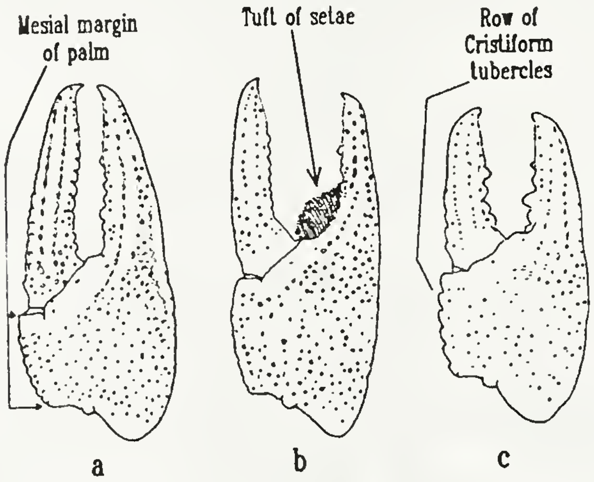


Fig. 10. Dorsal view of male right chela (modifeid from Hobbs, 1989). *a*, C. (*P.*) *buntingi*, showing 6 to 9 rows of tubercles on mesial margin of palm; *b*, C. (*H.*) longirostris, showing tuft of setae at base of fixed finger; *c*, C. (*J.*) *parvoculus*, illustrating cristiform tubercles on mesial margin of palm.

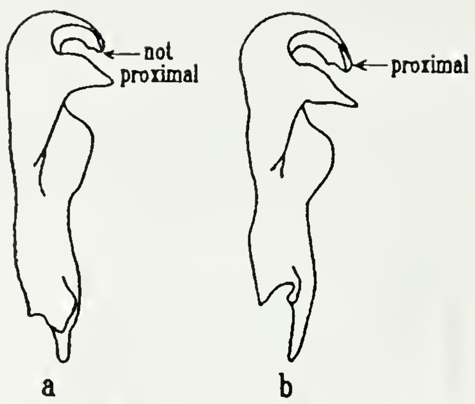


Fig. 11. Mesial view of Form-I gonopod (modified from Hobbs, 1989). a, C. (J.) dubius, with central projection not extending proximally to distal margin of thesesial process; b, C. (J.) parvoculus, illustrating central projection extending proximally to distal margin of the mesial process.

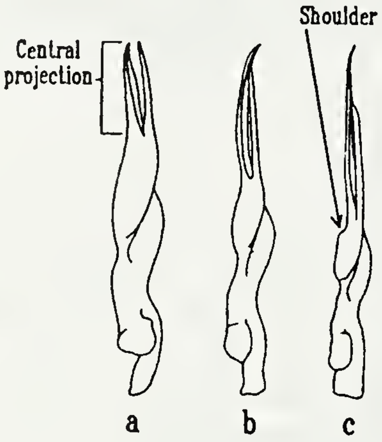


Fig. 13. Mesial view of Form-I gonopod (modified from Hobbs, 1989). *a*, O. (C.) *erichsonianus*, central projection no more than one-third of mesial length of gonopod; *b*, O. (*P.*) *forceps*, cephalic surface lacking shoulder at base of central projection; *c*, O. (*P.*) *spinosus*, cephalic surface with shoulder at base of central projection.

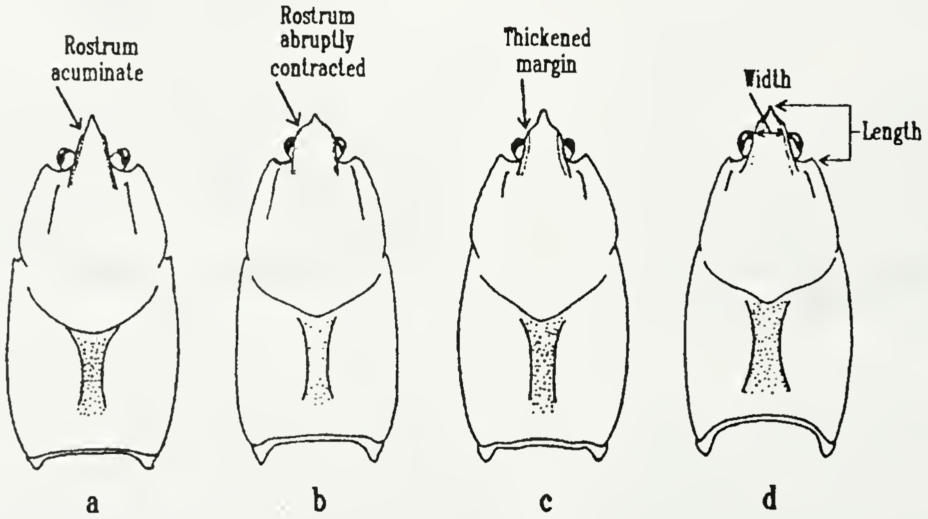


Fig. 12. Dorsal view of carapace (modified from Hobbs, 1989). *a*, C. (*P.*) *buntingi*, showing acuminate rostrum; *b*, C. (C.) *buntingii*, showing broad rostrum, margins not thickened; *c*, C. (C.) *angularis*, showing broad rostrum, margins abruptly contracted at base of acumen, and thickened rostral margins; *d*, C. (*H.*) *longirostris*, showing narrow rostrum with margins abruptly contracted at base of acumen.

7. Central projection of gonopod of Form-I male constituting about one-third of total length of appendage (Figs. 9c; 13a); annulus ventralis lacking deep transverse fossa, with weakly to moderately developed cephalolateral prominences (Fig. 14a); rostral margins subparallel, rostrum without median carina (Fig. 15c) .... O. *(Crockerinus) erichsonianus*

   Central projection of gonopod of Form-I male constituting nearly one-half of total length of appendage (Figs. 9c; 13b, c); annulus ventralis with deep transverse fossa and large, lobiform cephalolateral prominences (Fig. 14b); rostral margins concave without rostral carina (Fig. 15a) or subparallel with rostral carina (Fig. 15b) 8

8. Cephalic surface of gonopod of Form-I male lacking shoulder at base of central projection (Fig. 13b); fingers of chela strongly gaping (Fig. 16a); ventral surface of carpus of cheliped lacking distomedian spine or tubercle (Fig. 17b); rostral margins concave (Fig. 15a) .... O. *(Procericambarus) forceps*

   Cephalic surface of gonopod of Form-I male with distinct shoulder at base of central projection (Fig. 13c); fingers of chela never strongly gaping (Fig. 16b); ventral surface of carpus of cheliped with distomedian spine or spiniform tubercle (Fig. 17a); rostral margins concave or subparallel 9

9. Cutting edge of mandible (Fig. 8) smooth; rostral margins concave without median carina ... O. *(P.) rusticus*

   Cutting edge of mandible (Fig. 8) serrated; rostral margins subparallel, rostrum with median carina (Fig. 15b) .... O. *(P.) putnami*

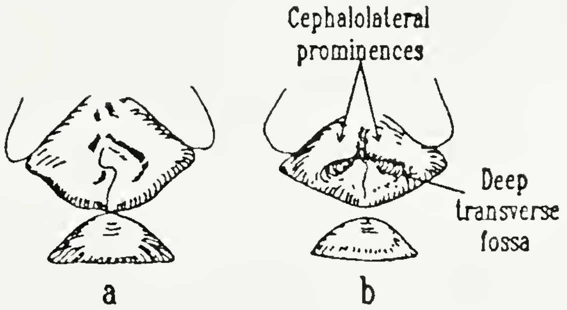


Fig. 14. Annulus ventralis and postannular sclerite of female (from Hobbs, 1989). *a*, O. (C.) *erichsonianus*, lacking deep transverse fossa; *b*, O. (P.) *spinosus*, with deep transverse fossa and prominent overhanging cephalolateral prominences.

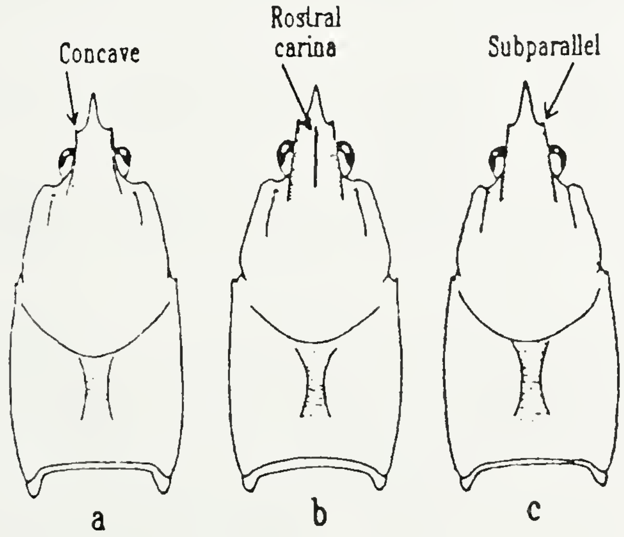


Fig. 15. Dorsal view of carapace (from Hobbs, 1989). *a*, O. (P.) *forceps*, showing concave rostral margins; *b*, O. (P.) *spinosus*, with subparallel rostral margins and rostral carina present; *c*, O. (C.) *erichsonianus*, rostral margins subparallel and rostral carina absent.

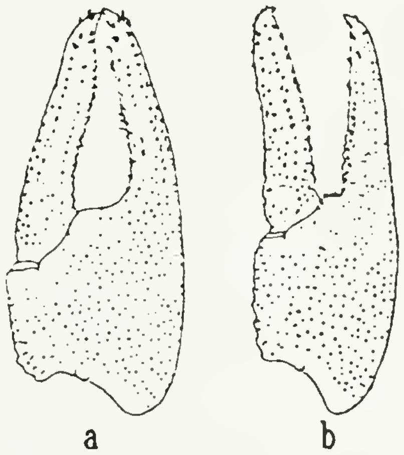


Fig. 16. Dorsal view of Form-I male right chela (from Hobbs, 1989). *a*, O. (P.) *forceps*, with strongly gaping fingers; *b*, O. (P.) *spinosus*, fingers not strongly gaping.

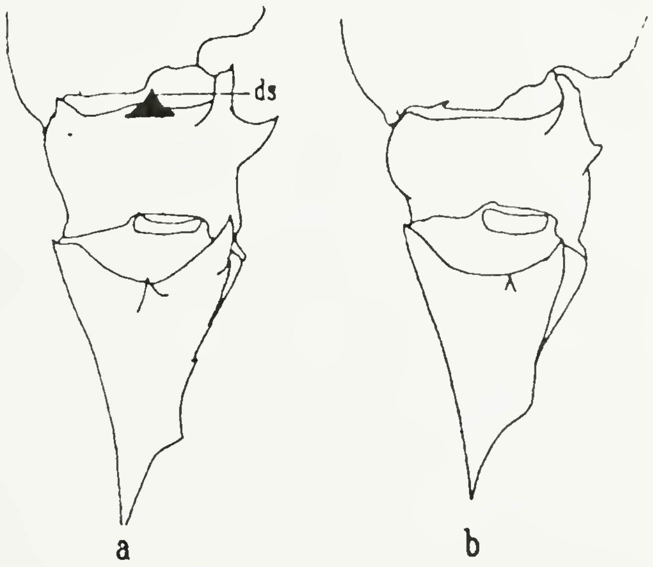


Fig. 17. Ventral surface of carpus of cheliped (from Hobbs, 1981). *a*, O. (P.) *spinosus*, distomedian spine (ds) or tubercle present; *b*, O. (P.) *forceps*, distomedian spine absent.

TABLE 2. GLOSSARY OF TERMS USED IN THE TEXT AND KEY.

acuminate - tapering to a point.
annulus ventralis- female sexual structure that receives sperm from the male gonopods; located between fourth pair of pereiopods on ventral surface (Fig. 8).
cephalic - toward the head.
cheliped- pereiopod I (Fig. 8).
cristiform - like a crest or cock's comb.
distal - away from the long axis of the body.
dorsal - "up" when the crayfish is held with the long axis of the body parallel to the ground.
fingers - the distal parts of the chela; the movable finger is the dactyl (Fig. 8).
Form-I and Form-II male - male crayfishes of the family Cambaridae alternate between a sexually mature and a sexually immature stage (Fig. 9a, b). The sexually mature males are referred to as Form-I, the sexually immature as Form-II (Payne 1978).
gonopod - pleopod I (Fig. 8) or first pleopod of male. The gonopods transfer sperm to the female.
lateral view of gonopod - with the long axis of the crayfish body held parallel to the ground, and the gonopods extended perpendicular to this axis, a lateral view of a gonopod is from the outside looking towards the middle of the body.
longitudinal- along the long axis.
mesial - towards the middle; inner.
mesial view of gonopod - with the long axis of the crayfish body held parallel to the ground and the gonopods extended perpendicular to this axis, a mesial view of a gonopod is from the middle of the body looking outward.
proximal - towards the long axis of the body.
punctations- tiny pores in the exoskeleton.
rostral carina - a flattened (in smaller specimens) to raised (in larger specimens) area in cephalomedian area of rostrum (Fig. 15b).
setae - hairs
subparallel - almost parallel.
subquadrate - nearly square.
transverse - perpendicular to the long axis of the body.
ventral - "down" when the crayfish is held with the long axis of the body parallel to the ground.

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Caddisflies from Greensville County, Virginia (Insecta: Trichoptera)

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INTRODUCTION

Despite several years (1976-1980) of intensive sampling by the second author and colleagues at VPI&SU, and a much longer period of more sporadic collecting by Oliver S. Flint, Jr. (USNM), the caddisflies of Virginia are still inadequately known, and this is particularly true for the fauna of southeastern Virginia. The only published list of the state's caddisflies (Parker & Voshell, 1981), which was based exclusively on material in the VPI&SU collection, accounted a total of 239 species. Recent collections by VMNH personnel and others have since added nearly a score of additional forms, and search through major museum collections will surely bring the actual number of species known for Virginia to well over 300.

Probably the great majority of existing records are for the mountainous western third of the state. Although extensive collections from Virginia are maintained at VPI&SU and USNM, and several regions have been thoroughly sampled, the Virginia distribution is not well-known for more than a handful of species and there is still no published list of species from any in-state locality. The present treatment is apparently a pioneer in this respect, although obviously it is far from being complete as at least 40 additional species are likely to be residents of the county.

During a brief visit to the Dismal Swamp in May 1963, the first author collected nine species of caddisflies that were attracted to a gasoline lantern. These were sent for identification to Dr. Herbert H. Ross, whose comment about them (in litt.) "The remarkable circumstance about this list is that it is typical of a spring fed stream in Long Island or in the Adirondacks rather than what we consider to be the fauna of a southern swamp" stimulated an interest in pursuing such an intriguing lead. Establishment of the VMNH in 1988, and employment there of the first author, finally provided the opportunity to conduct sampling in many places in the southeastern counties and cities. Greensville County was nuclear in this activity, partly because it had long figured in related efforts, and partly because of the diversity of aquatic habitats it encompassed. Material collected at UV light through the warmer months of 1989-1995 was transmitted to the second author for identification, and the resulting names were then associated with the various biotopes sampled. The considerable degree of site specificity thus revealed provided an additional justification (beyond the provision of a simple inventory baseline and faunal list) for preparing the following account. The rapidly decreasing rate of new additions to the species list suggests that (1) most of the commoner species have been collected, and (2) the documentation of additional species will require specialized sampling in different habitats at different seasons. The present total of 59 caddisflies recorded for Greensville County is probably at least 50% of the actual fauna, with the major deficiency being in species of Hydroptilidae (which is amazingly underrepresented in the collections made so far).

The Area

Greensville County spans the "Fall Line", just north of the Virginia-North Carolina border (Map 1). This geological and physiographic transitional zone is about 8-9.6 km in width and expresses itself at rocky outcrops and rapids at somewhat different latitudinal positions on the Nottoway and Meherrin, the two rivers that cross the county. Using the easternmost exposure of Piedmont bedrock as the definitive interface between Coastal Plain and Piedmont, a remarkably close concordance with the present course of U. S. highways 301 and I-95 and the CSX railroad can be observed. East of these markers, the terrain is flat (elevation ranging between 30 m near the Fall Line to about 15 m in most of the Meherrin River floodplain) and the subsurface strictly alluvial; westward the surface gradually rises to an eastern Piedmont level of about 45 m, with metamorphic bedrock generally exposed or near the surface.

The county has been farmed intensively since colonial times, especially the Piedmont sectors. Lumbering activities have converted the original forest into 3rd or 4th growth stands of mixed hardwoods, and in recent years the introduction of loblolly pine plantations has resulted in still further degradation.

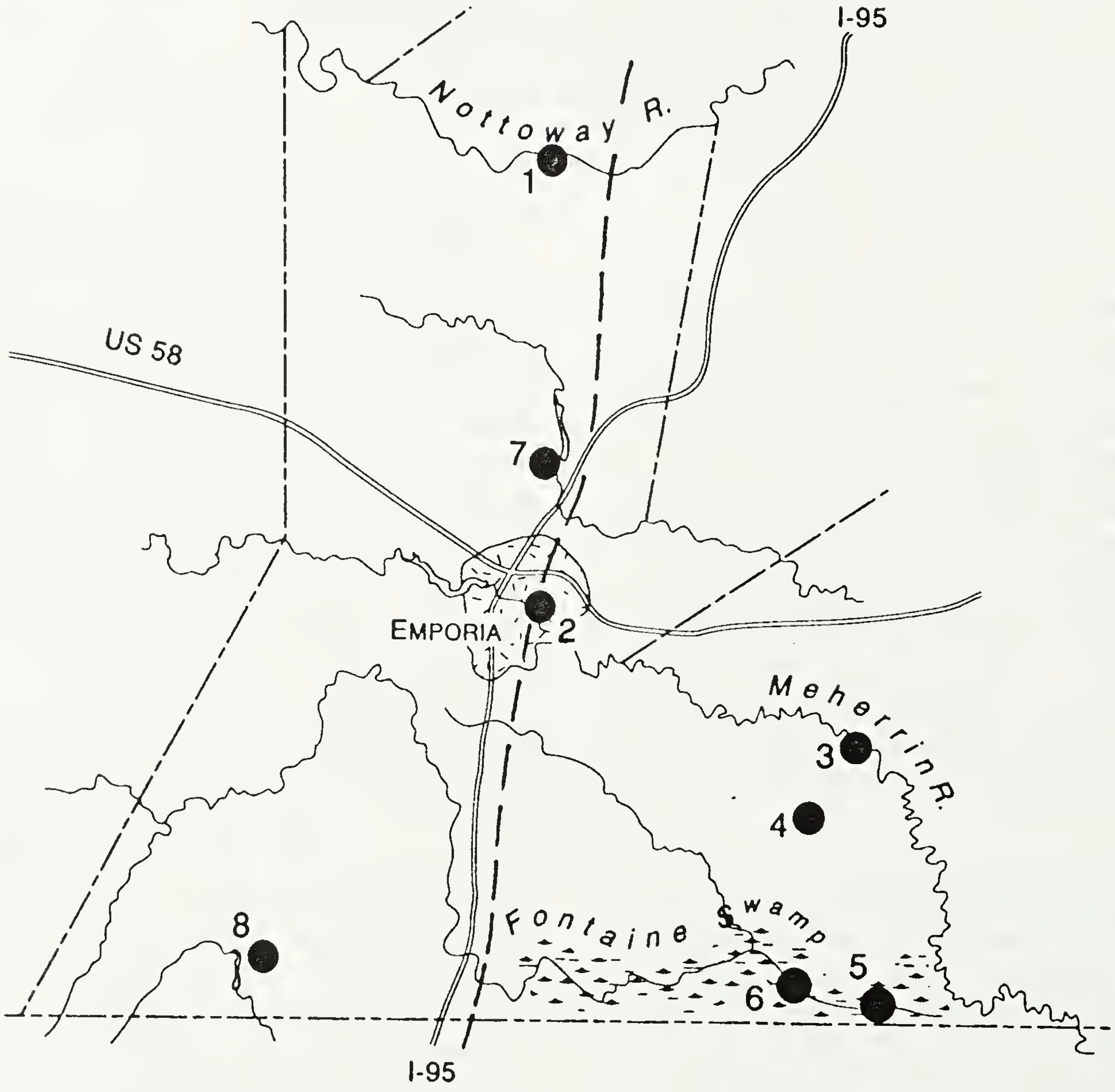

Figure 1. Map of Greensville County, VA. showing major streams and collecting localities. Eastern edge of Fall Line indicated by the dashed line. Numbers correspond to collecting sites discussed in text.

There is probably no "virgin forest" left in the county, in fact, very few old growth stands. Large areas are owned by lumber/paper interests, by whom they are managed in various ways: usually clearcut and replanted with pine, or clearcut and leased to private hunt clubs. There is no public land and therefore no organized protection. Growth and development are taking place rapidly; Emporia spreads outward along the county roads, and more and more timberland is being cleared annually for crop fields: the current crop in favor is cotton, replacing peanuts and soybeans of former years. Even riparian forests along the larger streams are increasingly vulnerable to the chain saw.

Despite the prevalence of large scale agriculture and the certainty of dissolved chemicals in runoff drainage, there is little evidence so far that the two major in-county streams (Three Creek to the north, and Fontaine Creek in the southern half), are negatively impacted. In both, the fauna of unionid mussels and other sensitive organisms is abundant and diverse. Of the two major rivers, the Meherrin is subject to more extreme flooding and carries a larger load of silt than the Nottoway, even though the two drain superficially similar basin environments. The larger number of caddisflies taken at the single Nottoway site may reflect its accessibility rather than an inherently larger fauna: the Meherrin at the Fall Line in Emporia is less amenable to light trapping and was sampled only once.

Collecting Methods

All collections were made with the use of a white bedsheet illuminated with a commercial ultraviolet ("blacklight") tube, operated from automobile battery power through the cigarette lighter outlet. The lighting period varied greatly and opportunistically, often starting at sundown and continuing on until 2200 or 2300 h, sometimes starting much later and lasting only an hour or so. On one occasion the trap was operated overnight. Specimens were picked off the sheet by hand and placed directly into 70% isopropyl alcohol. An attempt was made to capture selectively only a dozen or so of the larger or more distinctive species (e.g., *Phryganea sayi*, *Nectopsyche exquisita*) recognizable on the sheet, to reduce local depletion. Species less than 10 mm long (e.g., Leptoceridae, Polycentropodidae) were taken in greater numbers since field discrimination was impossible. Lastly, as many specimens of micro-caddisflies (Hydroptilidae) were taken as possible although this was never more than a negligible number and most of them were females. On several occasions, so many insects (usually species of *Ceraclea*) came to the light as to produce a kind of dense "force-field" extending nearly 0.5 m out from the sheet; close-range selection was then impossible and a widemouth jar, held at arm's length, was run up the height of the sheet at spaced intervals to secure a random sample. Two or three such passes usually would fill a 4 oz widemouth jar (unfortunately, so many of the captures were unidentifiable females). Collections attempted early in the season (February-March), even on warm damp nights, were usually unproductive, often only one or two moths visited the sheet; the same was true for late fall attempts, made much later than the end of October. As a rule, warm rainy evenings in midsummer gave the best yields.

It must be emphasized that the collections were NOT quantitative, and the figures given for the various samples give no idea of relative abundance. In many cases only a hundred specimens were taken from a sheet which would have easily yielded a thousand, and over-night trapping would have gathered many thousands. The limitations of short-term collecting periods are noted, in the sense that species emerging or flying during early morning hours were generally missed.

Aquatic Habitats Sampled

LENTIC:

A. **Rivers** (4th order streams with persistent current).

1. Nottoway River. This relatively large and unpolluted stream drains an area of about 1295 km^2 of southern Virginia Piedmont with the main headwaters near the town of Green Bay in Prince Edward County. Just south of Blackstone it drops some 24 m over an outcrop of granite at Nottoway Falls, below which its gradient is essentially near base level. West of the Fall Zone, it forms the northern boundary of Lunenburg, Brunswick, and Greensville counties. Below Stony Creek it crosses Sussex and Southampton counties and merges with the Blackwater River near Franklin. As far downstream as Courtland the Nottoway is a clean sandy-bedded shallow river with appreciable current, generally flowing through gallery forest. This section has been designated part of Virginia's Scenic Rivers system. Below Courtland a more lotic character is assumed: the water deeper, with less current.

During this survey the Nottoway was sampled at a boat landing site (1 on the map) just below the Va. Rt. 619 bridge, where the width is about 10-15 meters, average depth about 0.5 m, and the stream bed largely stones, boulders, and bedrock. The current is swift enough to make wading at knee depth difficult. Waterweed (*Justicia* cf. *americana*) is common along the banks in shallows, and the submerged rocks are thick with hornwort (*Podostemom ceratophyllum*). Several species of unionid mussels (*Elliptio* spp.) and pleurocerid snails (*Oxytrema* spp., *Mudalia* sp.) are abundant.

2. Meherrin River. The Meherrin is somewhat inferior to the Nottoway both in size (despite a larger drainage basin of about 1800 km^2) and water quality. Its drainage basin adjoins that of the Nottoway on the south, arising also in Prince Edward County near Keysville; its three headwater branches drain a mostly wooded region. It forms the boundary between Nottoway and Lunenburg counties, and bisects both Brunswick and Greensville counties as far as Emporia, where on entering the Coastal Plain it turns abruptly southeastward and assumes an excessively meandering course to the Virginia state line. This long convoluted reach (probably 50 river km) is entrenched some 3-6 meters in its broad floodplain, which it inundates almost annually. For most of this length the Meherrin is accessible only across private land, and it is often difficult to locate a source of permission. In passing through the city of Emporia, the Meherrin is impounded by a municipal hydroelectric facility, below which is a long deep eddy and some short intervals of swift water (Site 2). A few collections were made along this reach, the light operated some 20-30 m from the water. Several additional collections were made some 30 km downstream in the region described above (site 3, about 2.5 km ENE of Claresville), where the stream appeared clean and pleasant, with a fair variety of aquatic organisms (no trace of unionid mussels was detected anywhere on the Meherrin below Emporia, although a good population of about ten species persists in the mid-town eddy). Although the stream here has a low gradient and shallow sandy bed, frequently congested with logs and other flood debris it has a moderate current even during late summer low flow period.

LOTIC:

B. **Cypress-black gum swamps.** This habitat type was sampled fairly regularly at three sites. One of them (4) is a permanent shallow pond, about an acre in extent, located at the VMNH drift fence site about 2 km east of Claresville, at the end of Va. Rt. 666. This is on the western edge of the Meherrin floodplain and is inundated frequently. For most of the year, this region (about 1-2 km wide) remains above water, although it is laced with drainage ditches and isolated ponds and marshes. The site 4 pond retains its integrity throughout the year with extensive aid from local beavers, which maintain a low impoundment along the eastern periphery.

The major local tributary to the Meherrin River is Fontaine (a.k.a. Fountain) Creek, a clean second order stream originating on the Piedmont in southern Brunswick County. On entering the Coastal Plain, near the Virginia-North Carolina state line, this creek becomes Fontaine Swamp, originally a typical cypress-tupelo forest. Most of the original cypress has long since been removed, and even today harvesting of other species occurs on an irregular basis all along the periphery and on higher land. Despite such perturbation this extensive morass (some 20 km in length, and 3-5 km in width) is nonetheless of much biological interest as the inlandmost swamp of its kind in Virginia. Collecting site 5 is at the crossing of Va. 624, where for some distance both above and below the bridge the channel was dredged to produce a long reach of deep and essentially still water. Site 6 is about 6-7 km upstream, at the Va. 625 bridge (locally, the Iron Bridge); here the water level fluctuates drastically: during the spring floods it may achieve a depth (with swift current) of 1 to 2 meters; in late summer only a channel narrow enough to step across winds its way through mud flats and cypress knees. On balance, however, both of these sites would be classified as lotic most of the year.

C. **Mill ponds.** Abandoned mill ponds provide an artificial lotic habitat chiefly on the Fall Zone and outer Piedmont, where natural ponding does not occur. Two such ponds were visited fairly regularly and yielded a wide diversity of insects generally as well as caddisflies. Site 7 is at Slagle's Millpond ("Lake" on some maps), an impoundment of Three Creek located some 4 km north of Emporia. The age of this pond has not been determined, but minimally must be on the order of 80-100 years. Its surroundings are mostly deforested and cultivated, some forest persists on the east bank. The light was operated here at water's edge at a VDGIF boat landing. Site 8 is at Garner's Millpond, 12 km southwest of Skippers and well up onto typical Piedmont terrain of rolling hills and rocky streams. This pond is much smaller than the preceeding and in more wooded surroundings, it appears to be of about the same age as Slagle's. The light was operated here from a grassy hillside some 30 m upslope from the water's edge. It must be emphasized that in the case of both millponds, the light was operated within 100 m of a rocky and turbulent reach below the dam, and quite possibly species inhabiting such a biotope could readily have been attracted to the sheet along with stillwater forms.

List of species

Because of the inconclusively established phylogenetic sequence of families in the Trichoptera, we resort to a strictly alphabetical order for all levels in the following list. General statements about distribution are derived substantially from the maps in Harris, O'Neill & Lago (1991; symbolized as HOL in subsequent references) for those of our species which occur also in Alabama. For others we have referred to the information in Ross (1944) and any recent revisionary papers. Summary statements about distribution within Virginia are based primarily on material in the collection at VPI&SU, with occasional refinements from recent literature.

Family Glossosomatidae

1. *Protoptila palina* Ross. Site 1, Nottoway River, 29 August 1991 (5♂, 16♀), is the only Greensville locality for this species. *Protoptila. palina* has been reported from most states from Maine to Alabama but whether it is generally widespread or restricted to lower elevations seems not to be known. Except for one locality in Hanover County (Falls of the North Anna River, VPI&SU), the five Virginia counties of record for *palina* (Bath, Giles, Montgomery, Rockbridge, and Washington) are west of the Blue Ridge. Our Site 1 corresponds both geographically (Fall Line) and ecologically (stream type) to the Hanover locality.

Family Hydropsychidae

2. *Cheumatopsyche analis* (Banks). Site 6, Fontaine Swamp at Va. 625, 9 April 1980 (4); Site 7, Slagle's Millpond, 20 July 1989 (12); Site 8, Garner's Millpond, 19 June 1989 (10), 9 May 1991 (3); Site 4, 1.6 km E of Claresville, 7 August 1996 (3♂). All of the capture sites are lentic situations. This species is widely distributed over much of North America but appears to be only rarely taken in Virginia. VPI&SU has material only from Bedford and Shenandoah counties; none were taken by intensive and prolonged sampling on the North and South Anna rivers in the central Piedmont.

By contrast, Gordon & Wallace (1975) found *analis* to be one of the dominant hydropsychids in the Savannah River basin, as characteristic of streams or large rivers extending into the Coastal Plain, occuring at elevations from about 880 m to nearly sea level although primarily a Piedmont species. Its apparent absence from similar streams in Virginia, and Greensville occurrence only in lentic habitats, suggests a major geographic variation in habitat within this species.

This species has been known as *C. pettiti* (Banks) since the revision of this genus by Gordon (1974). However, the second author and O. S. Flint, Jr. believe that the action of Ross (1944) in declaring *pettiti* and *analis* to be synonyms constitutes a "first reviser selection" which establishes *analis* as the correct name.

3. *Cheumatopsyche campyla* Ross. Site 1, Nottoway River 29 August 1991 (5♂, 30♀). *Cheumatopsyche. campyla* is another caddisfly known from virtually all of North America (except perhaps for peninsular Florida). It was not common in Greensville County, and VPI&SU has material only from the Virginia counties of Louisa and Hanover in the Piedmont, and Montgomery, Rockbridge, and Shenandoah in the Ridge & Valley Province.

Gordon & Wallace (1975) note that in the Savannah River basin, *campyla* "...extended from the headwaters to the middle of the Piedmont", inhabiting large streams and medium sized rivers. Most of the localities mapped in Alabama by HOL are above the Fall Line, contributing to the impression that this species avoids the southeastern Coastal Plain.

4. *Cheumatopsyche ela* Denning. Site 1, Nottoway River, 9 June 1992 (9). Confined to eastern North America, from Quebec to Alabama (where it is widely dispersed but common only in a few Coastal Plain streams). Virginia localities are for 16 counties, none are in the Coastal Plain and most are in the westernmost Piedmont and mountains, again reflecting geographic differences in habitat preference.

Gordon & Wallace (1975) associated *campyla* and *ela* as inhabitants of large streams and medium-sized Piedmont rivers in the Savannah drainage basin.

5. *Cheumatopsyche harwoodi* Denning. Site 2, Meherrin River in city of Emporia, 16 August 1991 (3♂); Site 4, 1 mile east of Claresville, 9 May 1993 (1♂). Nova Scotia to Alabama, generally not common. Seven counties are represented in the VPI&SU collection, all but one of them (Louisa) in the mountains.

Under the name *C. enigma*, Gordon & Wallace (1975) recorded this species as inhabiting brooks and small rivers as far downstream as the middle Piedmont, in the Savannah River basin. Our Greensville County localities are at the Fall Line (Emporia) or just a few kilometers to the east of it (Claresville), the latter site however is unquestionably a lentic warm water habitat not typical for this species.

6. *Cheumatopsyche parentum* Gordon. Site 8, Garner's Millpond, 9 May 1991 (2♂; some or all of seven females taken at the same time may be this species). Virtually endemic to Virginia, this species was described from material taken at Bull Run Regional Park in Fairfax County, by O. S. Flint. It has been recorded (Gordon, 1974) also from nearby Prince Georges Co., Maryland. VPISU has specimens from Hanover, Louisa, and Patrick counties, implying a distribution throughout the Virginia Piedmont and doubtless that also of North Carolina since Greensville and Patrick county localities are virtually on the boundary between the two states.

7. *Cheumatopsyche pasella* Ross. Site 2, Meherrin River, 16 August 1991 (2♂, some or all of 30 females included in this sample may belong to this species); Site 4, 1 mile east of Claresville, 9 May 1993 (1♂), 7 August 1996 (28♂); Site 8, Garner's Millpond, 19 June 1989 (1♂). *C. pasella* is widespread in eastern United States, except perhaps for peninsular Florida. VPISU has material from Campbell, Louisa, and Hanover counties in the Piedmont, and Carroll and Pulaski in the Appalachians. In the Savannah River basin, *pasella* was found by Gordon & Wallace (1975) to prefer small to large rivers, from headwaters to the Coastal Plain.

8. *Hydropsyche alvata* Denning. Site 8, Garner's Millpond, 19 June 1989 (4), 7 June 1990 (10); Site 4, 1.6 km E of Claresville, 7 August 1996 (5♂). A species of the southeastern Coastal Plain and Interior Lowlands, *alvata* extends northward in Virginia to the Anna River system in Hanover and Louisa counties (Flint et al., 1979). In the Savannah River basin, Gordon & Wallace (1975) found *alvata* at only one station, about 200 m. elevation on the inner edge of the Piedmont. Absence of the species farther downstream in lentic reaches is curious, in light of the obvious preference for still water in Greensville County.

9. *Hydropsyche betteni* Ross. Site 8, Garner's Millpond, 7 June 1990 (7); site 7, Slagle's Millpond, 2 July 1989 (7). This species is widespread in eastern North America, but seems to avoid the southeastern Coastal Plain. VPISU material is from six counties in the Piedmont, three in the mountains, and one (King William) in the Coastal Plain.

10. *Hydropsyche incommoda* Hagen. Site 3, Meherrin River ca 2 miles E of Claresville, 16 August 1991 (2♂, O. S. Flint det.). The species ranges from Maryland to Alabama in the Coastal Plain and Piedmont, with disjunct localities in Ohio and Kansas. VPISU records for Virginia are for Chesapeake City in the outer Coastal Plain, Chesterfield, Hanover, and Louisa counties on or near the Fall Line, and Campbell County in the western Piedmont (an out-of-character record).

The Meherrin River at the capture site is sandy bottomed, and entrenched 2-3 m below the general level of the floodplain, with a definite current even during summer low volume. On the basis of this single collection, *incommoda* must be rated as scarce in the region. HOL state the species is common in large coastal plain rivers in Alabama; Gordon & Wallace stipulate large rivers in the lower Piedmont-Coastal Plain in the Savannah River basin.

11. *Hydropsyche rossi* Flint, Voshell, & Parker. Site 4, 1 mi. E of Claresville, 7 August 1996 (5); Site 8, Garner's Millpond, 9 May 1991 (2); Site 5, Fontaine Swamp at Va. 624 bridge, 25 May 1989 (3). [also unnumbered site, east side of Meherrin River at Hale's Ford bridge (Va. 730), in Southampton Co., Virginia, 25 May 1989 (3)]. This species is widespread in southeastern United States, north to Virginia and Indiana. VPISU records are from the City of Chesapeake, City of Richmond, and Louisa and Pittsylvania counties.

12. *Hydropsyche venularis* Banks. Site 1, Nottoway River, 29 August 1991 (30). The species is widespread in eastern United States, but uncommon in the Coastal Plain. VPISU records are from ten counties and cities, in the Piedmont and mountains. The single capture site is typical of a Fall Line reach, swift and rocky-bedded.

13. *Macrostemum carolina* Banks. Site 7, Slagle's Millpond, 20 July 1989 (6). Ranging from New York to Oklahoma in the Coastal Plain and northward to Illinois and Indiana, this species has a distinctly Austral distribution. Instate records are for seven counties and cities in the Coastal Plain and Piedmont.

14. *Macrostemum zebratum* Hagen. Site 1, Nottoway River, 8 June 1992 (8). This species appears to be somewhat more northern in range than the preceeding, with only widely scattered localities in the southeastern States. The majority of the 13 Virginia counties represented in VPI&SU material are in the Ridge & Valley Province, and the present capture site is the southeasternmost for the state.

Hydroptilidae

15. *Neotrichia vibrans* Ross. Site 1, Nottoway River, 8 June 1992 (1♂). This is the only site known for the county. This species occupies an extensive range in eastern North America but is unreported for many of the states. For Alabama, where it is statewide, HO&L state

that it occurred in most aquatic habitats from springs to large rivers and lakes.

16. *Orthotrichia* cf. *aegerfasciella* (Chambers). Site 1, Nottoway River, 11 September 1992 (1♀). Widespread in North America east of the Great Plains, this species occurs abundantly throughout Alabama where, according to HOL. it is found in both lotic and lentic habitats.

17. *Oxyethira forcipata* Moseley. Site 7, Slagles Millpond, 20 July 1994 (1♂). The species is widespread in eastern North America but in the southeast may avoid the Coastal Plain (as it definitely does in Alabama).

Lepidostomatidae

18. *Lepidostoma tibiale* (Carpenter). Site 1, Nottoway River, 8 June 1992 (8♂♀); also 29 August 1991 (3♀, probably this species). Originally described from the Great Smoky Mountains area, and currently known from southwest Virginia to central Alabama, *tibiale* is essentially endemic to the southern Blue Ridge mountains. The VPISU collection has Virginia material only from the New River in Carroll County. In light of this distribution, the discovery of *tibiale* on the Fall Line in Greensville County is a remarkable extension of known range - 190 miles/300 km - to the east and into a trenchantly different geographic region (Fig. 2). The lack of collections from elsewhere in Virginia suggests that perhaps the species is in a declining phase, occurring peripherally in widely scattered disjunct populations. HOL reported only six collections in intensely-collected Alabama.

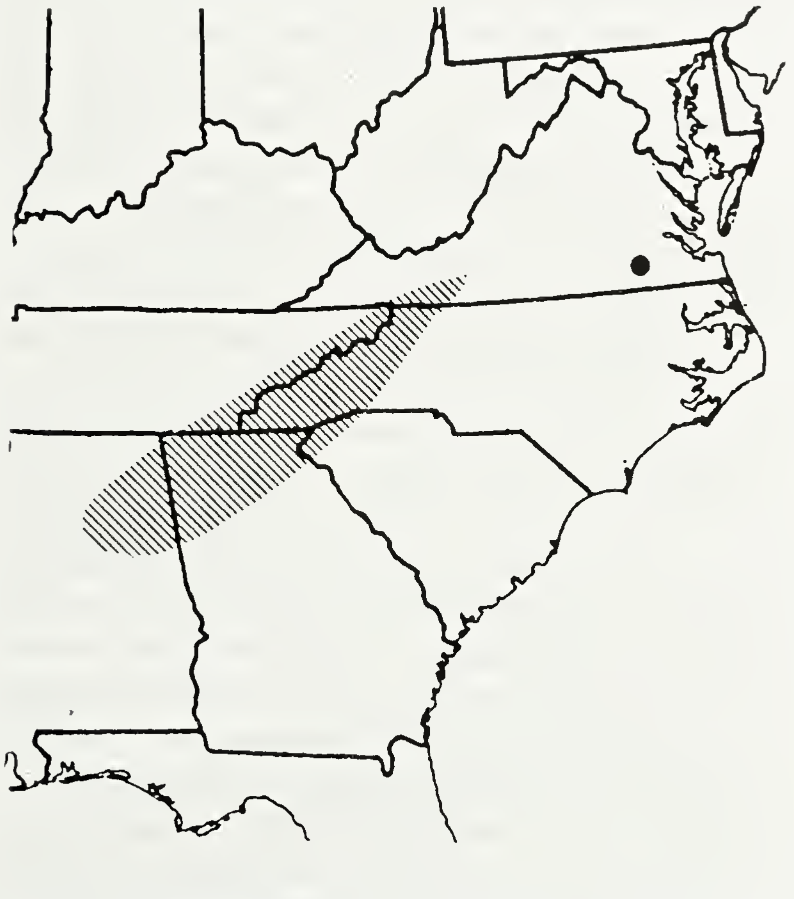

Figure 2. Approximate range of *Lepidostoma tibiale*(shading) with Greensville County locality shown by spot.

Although there is no reason to suspect confusion of labels or other curatorial mishap, the Nottoway River locality is so remarkable that confirmation by the capture of additional material at the site is desireable. Perhaps *tibiale* should be referred to a "Special Concern" status, and the Greensville site regularly monitored.

Leptoceridae

19. *Ceraclea cancellata* (Betten). Site 6, Fontaine Swamp at Va. 625, 25 May 1989 (5), 13 July 1993 (10). Site 4, 1.6 km E of Claresville, 3 June 1993 (12). Widespread across most of Canada and in the United States east of the Great Plains, *cancellata* occurs in the Piedmont and mountain regions of Virginia, with 14 counties represented by material in VPISU. Its capture only in still-water sites in Greensville County, instead of the lotic Nottoway River, is thus a little surprising. However, the species is abundant in the Coastal Plain of Alabama (HOL).

20. *Ceraclea diluta* (Hagen). Site 4, 1 km E of Claresville, 9 May 1993 (7). While the range of this species is similar to that of the preceeding, actual occurrences are notably scarce, both in Virginia (Hanover Co. only) and Alabama (a few sites in Baldwin, Mobile, DeKalb, and Madison counties only). Perhaps the flight season is earlier than usual for this genus. No specimens of *diluta* have been taken at Site 4 on any of the sampling dates later in the year, although collecting was done at the same place each time. Or perhaps Site 4 is only a marginal habitat, and the preferred biotope has not yet been discovered.

21. *Ceraclea maculata* (Banks). Site 6, Fontaine Swamp, 13 July 1993 (3); Site 7, Slagle's Millpond, 20 August 1989 (10); Site 8, Garner's Millpond, 19 June 1989 (2), 7 June 1990 (3). *C. maculata* is transcontinental across Canada, and occurs over most of eastern United States. HOL considered it to be the most frequently collected *Ceraclea* in Alabama, but VPISU has the species from only five counties, dispersed across the state, in Virginia. In Greensville County the species appears to be partial to lentic habitats.

22. *Ceraclea nepha* (Ross). Site 8, Garner's Millpond, 9 May 1991 (♂♀). Widespread in the Coastal Plain and Interior Lowlands of eastern United States. Statewide and eurytopic in Alabama, but considered as "never abundant"

(HOL). The species has apparently not been recorded from Virginia, although it extends northward to Delaware. It was not recollected at Garner's Millpond despite trapping at the same site in June.

23. *Ceraclea ophioderus* (Ross). Site 7. Slagle's Millpond, 20 July 1989 (5♂♀). Like the preceeding species, *ophioderus* is confined to the southeastern Coastal Plain and Interior Lowlands, and has not been recorded from Virginia. In addition to the single Greensville locality, VMNH has 20 specimens from a small stagnant stream in the Banister River floodplain, 5.3 km east of Five Corners, Halifax Co., Virginia, 25 July 1992. Although technically on the Piedmont, this site has a distinctly lowland facies and is not inconsistent with a general Coastal Plain range for the species.

24. *Ceraclea protonepha* Morse & Ross. Site 5, Fontaine Swamp at Va. 624 bridge, 25 May 1989 (12); site 6, Fontaine Swamp at Va. 625 bridge, 19 May 1991 (7), 20 May 1987 (1); 25 May 1989 (many). This species is essentially another southeastern endemic, occurring from Delaware to Florida, west to Louisiana and Kentucky, with a disjunct locality in Kansas. Apparently the only previous Virginia record is that of the type locality, Lake Drummond, Dismal Swamp. A small sample (VMNH 3) is from the Meherrin River floodplain in Southampton Co., Va , just east of the Va. 730 bridge, 20 May 1989. In Greensville County *protonepha* is not uncommon in Fontaine Swamp, but curiously has not been captured elsewhere in lentic habitats. A short flight period in mid-May is suggested by the several capture dates.

25. *Ceraclea slossonae* (Banks). Site 1, Nottoway River, 8 June 1992 (6), 20 August 1991 (15). Apparently endemic in eastern United States, this species is widespread in Virginia as implied by VPISU samples from Carroll, Culpeper, Grayson, Hanover, Louisa, and Montgomery counties in addition to the present Greensville Co. site. None of the localities, however, are in the Coastal Plain, and the species perhaps requires flowing, aerated streams.

26. *Ceraclea tarsipunctata* Vorhies. Site 1, Nottoway River, 8 June 1992 (10); site 6, Fontaine Swamp, 9 May 1991 (3), 25 May 1994 (30); site 8, Garner's Millpond, 7 June 1990 (10), 19 June 1989 (1). One of the most widespread caddisflies in North America, *tarsipunctata* is continentwide except for the southern Rockies and Great Plains. It is statewide in Alabama (HOL), and in Virginia occurs (14 counties) from sea level in Virginia Beach to the high mountains in Smyth and Giles counties. Greensville capture dates imply a May-June flight period and occupation of both large rivers and cypress swamps.

27. *Ceraclea transversa* (Hagen). Site 5, Fontaine Swamp, 25 May 1989 (1); site 6, Fontaine Swamp, 25 May 1989 (6). Another species continentwide in Canada but restricted to eastern United States, extending southward to Louisiana and Florida. VPISU material from Virginia is from eight counties in the mountainous part of the state, but *transversa* is known also from the District of Columbia and Delaware, and the Coastal Plain of Alabama, so its presence in Fontaine Swamp is not as unusual as its apparent absence from the intensely-collected Anna River system in Piedmont Virginia.

28. *Nectopsyche candida* (Hagen). Site 7, Slagle's Millpond, 24 August 1995 (3). Widespread in eastern North America, *candida* is chiefly a Coastal Plain species in Alabama and possibly also in Virginia.

29. *Nectopsyche exquisita* (Walker). Site 1, Nottoway River, 8 June 1992 (50), 29 August 1991 (25); site 4, 1 mile east of Claresville, 7 August 1996 (6); site 7, Slagle's Millpond, 20 August 1989 (1); site 8, Garner's Millpond, 19 June 1989 (2). Eastern North America, east of the Great Plains. In Virginia, the species is known from the Piedmont and mountains only, aside from our single Greensville site 4. VPISU material is from 14 counties. Although inhabiting lentic biotopes, *exquisita* is most numerous in swift water. At the Nottoway River site, the species occurred in astronomical numbers and 500 could have been taken as easily as 50.

30. *Nectopsyche pavida* (Hagen). Site 1, Nottoway River, 29 August 1991 (2); site 2, Meherrin River, 16 August 1991 (3); site 6, Fontaine Swamp, 13 July 1993 (6). Of general distribution in eastern North America, *N. pavida* is perhaps more abundant in lowland areas; stated by HOL to occur in nearly every aquatic situation in coastal plain Alabama. Virginia localities are in the Coastal Plain and Piedmont: Chesapeake City and Louisa County in VPISU, Greensville, Charlotte, and Southampton in VMNH; some preference for larger lentic habitats is suggested by collection sites.

31. *Oecetis cinerascens* (Banks). Site 2, Meherrin River in Emporia, 16 August 1991 (5); site 7, Slagle's Millpond, 20 July 1989 (9); site 8, Garner's Millpond, 7 June 1990 (3). Widely distributed but not collected in large numbers. HOL state that in Alabama, *cinerascens* was often collected in sluggish streams and impoundments, a proclivity reflected by the two lentic sites in Greensville County. Floyd (1995) attributed the species to both lentic and lotic habitats, predominantly the former. Specimens in VPISU were taken chiefly in the Coastal Plain (four counties or cities) or on the Fall Line (two counties).

32. *Oecetis ditissa* Ross. Site 8, Garner's Millpond, 19 June 1989 (4). Although not described until 1966, this species is widespread and abundant in southeastern United States, north as far as Massachusetts and Illinois. In Virginia existing records (VPI&SU) are for the Piedmont and Coastal Plain exclusively.

33. *Oecetis inconspicua* (Walker). Site 1, Nottoway River, 29 August 1991 (6); site 4, 1.6 km east of Claresville, 9 May 1993 (6); site 7, Slagle's Millpond, 20 July 1989 (10); site 8, Garner's Millpond, 7 June 1990 (2), also 19 June 1989 (10). Said by Ross (1944) to be the commonest caddisfly in North America, *inconspicua* is statewide in Virginia where recorded from 30 counties (although it is possible that a number of distinct species are currently subsumed under the name *inconspicua*).

34. *Oecetis nocturna* Ross. Site 2, Meherrin River in Emporia, 16 August 1991 (7); site 3, Meherrin River ca 4.8 km NE of Claresville, 1 August 1994 (1); site 4, 1.6 km east of Claresville, 7 August 1996 (1). This species, although not described until 1966, is generally distributed in eastern United States, and statewide in both Alabama and Virginia. According to Floyd (1995) it inhabits both lentic and lotic biotopes.

35. *Oecetis osteni* Milne. Site 7, Slagle's Millpond, 24 August 1995 (45). The range of this species appears to fall into two areas: one extending from Quebec westward through the Great Lakes region, another extending southward through the Atlantic Coastal Plain as far as Louisiana. It was mentioned for Virginia in the original description (basis unknown), but is not represented in the VPISU material; the present record may constitute the first specific state locality.

36. *Oecetis persimilis* (Banks). Site 5, Fontaine Swamp, 13 July 1993 (12); site 7, Slagle's Millpond, 20 July 1989 (1); site 8, Garner's Millpond, 7 June 1990 (9), also 19 June 1989 (5). Generally distributed over eastern North America, and nearly statewide in Virginia (11 counties in VPI&SU) although there are no records east of those given here.

37. *Oecetis sphyra* Ross. Site 1, Nottoway River, 29 August 1991 (12). Originally described from southern Georgia, this species ranges from eastern Virginia to Louisiana, with an inland occurrence in Tennessee. In Virginia it is recorded (VPI&SU) from the North and South Anna rivers near the Fall Line in Hanover and Louisa counties. Floyd (1995) considers the species to be confined to lotic habitats.

38. *Triaenodes abus* (Milne). Site 4, 1.6 km east of Claresville, 7 August 1996 (2). Widespread in North America east of the Great Plains, it is apparently sparsely distributed in small populations. Only four specimens were taken in four localities in intensely collected Alabama. This is the first published record for Virginia. VMNH also has a single male taken at the Va. 617 bridge on Exol Swamp, King & Queen Co., Virginia, 19 May 1993.

39. *Triaenodes flavescens* Banks. Site 1, Nottoway River, 29 August 1991 (12). The species is widely distributed in eastern North America, although records for the southeastern Coastal Plain are few. Virginia records in VPISU are mostly from the mountain counties, with a few in the Piedmont. Greensville County is the easternmost for the state; the single collection site is on the Fall Line in a distinctly lotic biotope. Absence of the species from collections made at the same site earlier in the season suggests a relatively short flight period in late summer.

40. *Triaenodes ignitus* (Walker). Site 8, Garner's Millpond, 19 June 1989 (1). Although generally distributed over eastern North America, and common in nearly every county in Alabama, *ignitus* is not often collected in Virginia. Samples in VPISU and VMNH are for the Piedmont (Hanover, Henry, Mecklenburg, Pittsylvania counties) and Coastal Plain (Greensville Co. and City of Chesapeake) only.

41. *Triaenodes ochraceus* (Betten & Moseley). Site 5, Fontaine Swamp, 25 May 1989 (9), site 6, Fontaine Swamp, 20 May 1987 (3), also 25 May 1989 (5). *T. ochraceus* occurs primarily in the Coastal Plain between Delaware and Mississippi, with a northward extension into the Cumberland Plateau in Tennessee. The present material apparently is the first to be recorded for the species in Virginia although it is known from Delaware and North Carolina.

Limnephilidae

42. *Ironoquia punctatissima* (Walker). Site 5, Fontaine Swamp, 31 October 1989 (5♂♀). Generally distributed in eastern North America, this species is also widespread in the Virginia mountains and Piedmont, with a few localities on or just east of the Fall Line. Most collections seem to have been made from the vicinity of swift cold mountain streams, so that the lentic site in Fontaine Swamp seems distinctly atypical. The species is surely more general in Greensville County than the single record would suggest.

43. *Platycentropus radiatus* (Say). Site 5, Fontaine Swamp, 10 May 1991 (3), 20 May 1987 (7), 25 May 1989 (1). Widespread and abundant in much of eastern United States, this species is nearly statewide in Virginia and occurs eastward essentially to sea level at Dragon Run in

Middlesex County. It is curious that only one collecting station in Greensville County has so far produced specimens of *radiatus*. The flight period in the Coastal Plain seems to be confined to May; further inland, summer collections have been made.

44. *Pycnopsyche indiana* Ross. Site 5, Fontaine Swamp at Va. 625 bridge, 31 October 1989 (3). Although this species is generally distributed in eastern United States from Michigan to South Carolina, collection stations are not numerous. VPISU material from Carroll and Montgomery counties consists of single females; as these are the only records for the entire Appalachian region, confirmation from males is highly desireable (all other localities are from the Coastal Plain or Interior Lowlands). VMNH has a collection from Namozine Creek, Dinwiddie Co., 22 September 1992 (7), a slow-water biotope on the central eastern Piedmont. A male from Ferncliff, Louisa Co., 27 September 1936, T. H. Frison (INHS) provides an additional Piedmont locality.

45. *Pycnopsyche virginica* (Banks). Site 1, Nottoway River, 16 October 1996 (1). This species has a limited distribution in the southeastern states from Virginia to Alabama. Originally described from Richmond, Virginia, *P. virginica* was a somewhat enigmatic species until its status was clarified by Flint (1966). VMNH has material (1♂) from a third in-state locality: the Blackwater Ecologic Preserve, 6.4 km south of Zuni, Isle of Wight Co., 22 October 1992, S. M. Roble leg. Perhaps the lateness of the flight season is responsible for the paucity of locality records. The single specimen reported for Alabama by HOL was taken in November.

Molannidae

46. *Molanna blenda* Sibley. Site 4, 1.6 km east of Claresville, 9 May 1993 (1). Although widely distributed in North America east of the Great Plains,and locally abundant in several areas, *M. blenda* is not frequently collected. Only 29 specimens were taken in intensely collected Alabama (HOL), and VPI&SU has material only from six Virginia counties, four of them in the mountains. The present record is the only locality for the Virginia Coastal Plain.

Philopotamidae

47. *Chimarra moseleyi* Denning. Site 5, Fontaine Swamp, 25 May 1989 (2); site 8, Garner's Millpond, 7 June 1990 (3). This species occupies the Coastal Plain and outer Piedmont from Virginia to Mississippi, and the Interior Lowlands (Missouri to Indiana). VPISU material is from the Fall Line region in Hanover Co. and slightly to the west in Louisa County.

48. *Chimarra obscura* (Walker). Site 1, Nottoway River, 8 June 1992 (15), also 29 August 1991 (5). Recorded from most of the eastern States and Provinces, this species is widespread in the Piedmont and mountain regions of Virginia (10 counties, VPI&SU), with no Coastal Plain localities.

49. *Chimarra socia* Hagen. Site 6, Fontaine Swamp, 13 July 1993 (3). The range of this species is confined to northeastern North America, southward through the Appalachians to northern Alabama and Arkansas. VPI&SU Virginia records are for Bath, Giles, and Rockbridge counties in the mountains, and Louisa County in the central Piedmont. The presence of *socia* in Fontaine Swamp is therefore somewhat surprising as the biotope does not seem appropriate for this species of upland streams.

Phryganeidae

50. *Phryganea sayi* Milne. Site 4, 1 km east of Claresville, 23 August 1995 (2); site 7, Slagle's Millpond, 24 August 1995 (2). This species occupies a northern range, from Quebec to North Dakota, southward as far as Kansas and northern Alabama. It is essentially statewide in Virginia, with the majority of county records in the Piedmont region. The absence of collections from the Nottoway River site is of interest, as is the apparently very short flight period of adults.

51. *Ptilostomis postica* (Walker). Site 4, 1 km east of Claresville, 9 May 1993 (6), also 12 September 1994 (7); site 6, Fontaine Swamp, 31 August 1979 (VPI&SU), also 25 May 1989 (1). The species is generally distributed over eastern North America, but apparently less frequent in the southeastern States. It is rarely taken in Virginia, VPISU having material only from Loudoun and Montgomery counties. HOL state that in Alabama *postica* is most often collected from large rivers and streams, in contrast to the lentic nature of capture sites in Greensville County.

Polycentropodidae

52. *Cernotina spicata* Ross. Site 7, Slagle's Millpond, 24 August 1995 (4). Ranging from Ontario and Michigan south and west to Florida and Oklahoma, *spicata* is represented in the VPISU Virginia material only from the North Anna River in Louisa and Hanover counties (where taken in large numbers). A Coastal Plain-outer

Piedmont range is thus implied for this state, against a statewide distribution in Alabama.

53. *Cyrnellus fraternus* (Banks). Site 2, Meherrin River in Emporia, 16 August 1991 (6), site 7, Slagle's Millpond, 24 August 1995 (2). Although generally distributed in eastern United States, this species is rarely collected in Virginia. VPI&SU has material from only four counties, chiefly in the Piedmont and Coastal Plain. The Emporia site is near a short reach of riffles between two long eddies; it was not possible to know from which habitat the specimens originated. Likewise, at Site 7, it is not known if the specimens came from the millpond or the turbulent reach below the dam itself.

54. *Neureclipsis crepuscularis* (Walker). Site 1, Nottoway River, 8 June 1992 (1); site 7, Slagle's Millpond, 20 July 1989 (1). Continentwide in Canada, this species is largely confined to the eastern half of the United States where widespread and common. VPI&SU has material from eight Virginia counties in the mountains and one (Hanover) on the outer Piedmont. The species is probably partial to flowing water habitats.

55. *Nyctiophylax affinis* (Banks). Site 7, Slagle's Millpond, 20 July 1989 (3). Like many other boreal caddisflies, *affinis* is continentwide in Canada, but largely restricted to eastern United States (where it does extend south to Florida and Texas). VPI&SU has material from Giles County in the Virginia mountains, Hanover and Louisa in the Piedmont, and King & Queen in the Coastal Plain, suggesting a statewide but very sporadic distribution.

56. *Nyctiophylax celta* Denning. Site 8, Garner's Millpond, 9 May 1991 (1). This species occurs east of the Mississippi River, from Quebec to the Gulf of Mexico. Existing capture records for Virginia (VPI&SU) are for the mountain counties of Bath, Giles, Rockbridge, and Rockingham. The Greensville site is an interesting range extension, although *celta* does occur sporadically in the Alabama Coastal Plain.

57. *Nyctiophylax moestus* (Banks). Site 6, Fontaine Swamp, 9 May 1991 (1). The range of this species is similar to that of the preceeding, but not extending quite so far southward, and seems to avoid the southeastern Coastal Plain. VPI&SU records are only from Floyd and Rockbridge counties in the mountains, so that the capture in Fontaine Swamp provides a disjunct Virginia range analogous to that of *N. celta*. Although there is no reason to doubt the documentation of the specimen, confirmation by future collections at the site is nonetheless desirable.

58. *Phylocentropus placidus* (Banks). Site 5, Fontaine Swamp, 25 May 1989 (2); site 6, Fontaine Swamp, 8 April 1980 (15), also 31 August 1979 (2). New Brunswick to Texas and Florida, east of the Great Plains; statewide in both Virginia and Alabama. The long adult activity period in Fontaine Swamp seems noteworthy.

59. *Polycentropus crassicornis* (Walker). Site 6, Fontaine Swamp, 20 May 1987 (1). Although this species is generally distributed over eastern North America, it seems not to be recorded for Virginia.

In addition to the above record, VMNH has this species from 1.6 km SE of Dunnsville, Essex Co., D. R. Smith leg. 18-31 May 1994 (20, O. S. Flint det.), and the Meherrin River floodplain at Va. 730 bridge, Southampton Co., 25 May 1989 (3). A male from Lake Drummond, Dismal Swamp, City of Chesapeake, 19 May 1963, is in the Illinois Natural History Survey. Collectively, the records suggest a strictly Coastal Plain distribution in Virginia.

DISCUSSION

The fact that the present list accounts for only half of the caddisflies likely to be found in Greensville County mandates that inferences drawn from existing data be expressed in the most general terms. In particular, the future use of all-night light trapping at many different localities (and earlier in the season) will surely modify the present findings substantially. That said, however, it is possible to select some obvious trends and specify noteworthy range extensions and other faunistic refinements. Reference to Table 1 will indicate quickly which species were taken at which of the eight sampling sites, these in turn categorized on the basis of their major ecological features (as defined in the introductory section). For comparisons based on temporal distribution, even though inconclusive, are comparable in the sense of having been made at exactly the same location at the site involved, and for essentially the same time period (normally for two hours after twilight).

The numbers of taxa (and individuals) recorded from each site represent only those identifiable to species: nearly each place yielded additional genera in the form of females which could not be taken to species with assurrance. In addition to the 59 species listed here, there are two males of an additional, apparently undescribed *Hydropsyche*, considered to be very close to *H. rossi* by Dr. Flint.

Additions to the Virginia fauna: Five species appear to be recorded for the state for the first time, these are

Ceraclea nepha, *Ceraclea ophiodera*, *Triaenodes abus*, *Triaenodes ochraceus*, and *Polycentropus crassicornis*.

Significant range extensions: The occurrence of *Lepidostoma tibiale* at the Nottoway River site is an unsual departure from the otherwise exclusively "Southern Appalachian" distribution of the species (Fig. 2). *Chimarra socia* is a species whose distribution is distinctly more northern (subboreal) and whose presence in the Coastal Plain of southeastern Virginia suggests postglacial climatic reliction.

Site diversity: The total figures for each site on Table I are lower than in actuality, since caddisflies which could only be identified to genus (females) are not included. Also, the intensity of sampling varies greatly: only one two-hour period at Site 2, as opposed to repeated trapping at sites 1, 4, 5, 6, 7 and 8. The table reflects a few generalities: limnephilids, phryganeids, and polycentropodids strongly favored still water habitats. Hydropsychids and leptocerids appear to be generalists, with no single higher taxon partial to lotic environments. The best sampled sites have total species numbers near 20, with the swift and rapid Nottoway River at site 1 not favored over millponds. The possibility should be recalled that "mixed" faunas could exist at each millpond, in that lotic species living below the dam spillways could have been attracted to the light set a hundred meters away beside the pond itself. Totals for the three primary biotopes surveyed show very little deviation: 28, 29, and 29 for rivers, swamps, and millponds respectively.

Site specificity: The total line "unique to site " reflects how many species were taken only at the individual site. Thus, of a total of 19 identifiable species at Site 1, 12 (63%) occurred nowhere else, by far the greatest degree of "local endemism". At site 7, 8 of the 18 species captured (44%) occurred nowhere else. None of the six found at site 2 occurred there exclusively. Only ten of 59 species (17%) were found in both lentic and lotic habitats.

Stenotopism: No species occurred in as many as six of the eight sites. The most euryzonal species is *Nectopsyche exquisita*, found in five. Six species occurred in 4 sites; eight in 3; 12 in 2, and 33 in just one. Although this figure will surely be modified by future collecting, it strongly suggests very local population distributions, and encourages the view that future additions will come from small or obscure habitats harbouring one-site species.

Flight seasons: By chance, the only site with collections made over much of the flight season was at the Nottoway River site 1, it therefore provides the only opportunity for noting faunal changes during the summer by species succession (Table II). As noted above, the collecting protocol at this site was consistent as to exact placement of the light (on the VDGIF boat landing), and the duration of the collecting period.

The table shows that of the ten species (many unidentifiable females not included even if in other genera) collected on June 8, five (50%) were not recaptured 12 weeks later. Of the 11 species taken in late August, five were not found either earlier or later. Five species did occur from early June to late August, and one extended from late August to mid-October.

Twelve species found at Slagle's Millpond, site 7, show an even more stringent seasonal restriction. *Oecetis inconspicuus* was collected only in May; *Cheumatopsyche analis*, *Hydropsyche betteni*, *Macrostomum carolinum*, *Ceraclea ophiodera*, *Oecetis cinerascens*, and *Neureclipsis crepuscularis* only in July; and *Nectopsyche candida*, *N. exquisita*, *Oecetis osteni*, *Phryganea sayi*, and *Cernotina spicata* only in August. However, these time intervals were not necessarily observed by these twelve species at other sites.

The seasonal occurrence of 13 species of Hydropsychidae - irrespective of site - was examined (Table III). Only *Cheumatopsyche analis* was flying from early April to early August. *C. harwoodi* and *Hydropsyche rossi* occurred from early May to early August, but there were no June-July captures for either one (two separate broods?). *C. parentum* was taken only in early May; *C. ela* and *Macrostomum zebratum* only in early June; *M. carolina* only in late July; *Hydropsyche incommoda* only in mid August; and *C. campyla* and *H. venularis* in late August.

ACKNOWLEDGMENTS

We want to express our thanks to those who have assisted in various ways toward the completion of this report. Dr. K. L. Manuel identified some of the more difficult leptocerids; Dr. Oliver Flint did the same for hydropsychids. The Meherrin Hunt Club, through Bain Drummond, allowed access to extensive private holdings in the floodplain east of Claresville. John M. Anderson assisted in much of the field work, and contributed the computer generated tables I-III. Susan C. Kirby compiled locality data from the VPI&SU collection, and performed other clerical duties. Dr. S. M. Roble participated in field work, especially in operating a blacklight trap for all-night collection at site 4.

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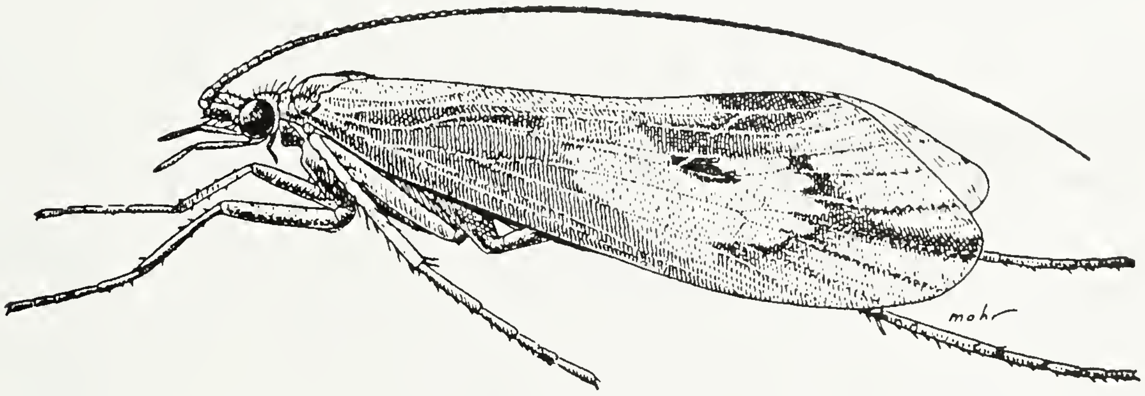

Platycentropus radiaiatus(Say), (from Ross, 1944)

TABLE I

SPECIES \ BIOTOPES	LOTIC			LENTIC				
	NOTT.	MEHERRIN		SWAMPS			MILLPONDS	
	1	2	3	4	5	6	7	8
Glossosomatidae								
Protoptila palina	●							
Hydropsychidae								
Cheumatopsyche analis				●		●		
Cheumatopsyche campyla	●							
Cheumatopsyche ela	●							
Cheumatopsyche harwoodi		●		●				
Cheumatopsyche parentum								●
Cheumatopsyche pasella		●	●	●				●
Hydropsyche alvata			●	●				●
Hydropsyche betteni							●	●
Hydropsyche incommoda			●					
Hydropsyche rossi			●	●	●			●
Hydropsyche venularis	●							
Macrostemum carolina							●	
Macrostemum zebratum	●							
Hydroptilidae								
Neotrichia vibrans	●							
Orthotrichia cf. aegerfasciella	●							
Oxyethira forcipata							●	
Lepidostomatidae								
Lepidostoma tibiale	●							
Leptoceridae								
Ceraclea cancellata	●			●		●		
Ceraclea diluta				●				
Ceraclea maculata				●		●	●	●
Ceraclea nepha								●
Ceraclea ophioderus							●	
Ceraclea protonepha					●	●		●
Ceraclea slossonae	●							
Ceraclea tarsipunctata	●					●		●
Ceraclea transversa					●	●		
Nectopsyche candida							●	
Nectopsyche exquisita	●		●	●			●	●
Nectopsyche pavida	●	●	●			●		
Oecetis cinerascens		●					●	●
Oecetis ditissa								●
Oecetis inconspicua	●			●			●	●
Oecetis nocturna		●	●	●				
Oecetis osteni							●	
Oecetis persimilis			●		●	●	●	●
Oecetis sphrya	●							
Triaenodes abus				●				
Triaenodes flavescens	●						●	

TABLE I (continued)

BIOTOPES / SPECIES	LOTIC			LENTIC				
	NOTT.	MEHERRIN		SWAMPS			MILLPONDS	
	1	2	3	4	5	6	7	8
Leptoceridae (continued)								
Triaenodes ignitus								•
Triaenodes ochraceus					•	•		
Limnephilidae								
Ironoquia punctatissima					•			
Platycentropus radiatus					•			
Pycnopsyche indiana					•			
Pycnopsyche virginica	•							
Molannidae								
Molanna blenda				•				
Philopotamidae								
Chimarra moselyi					•			•
Chimarra obscura	•						•	
Chimarra socia						•		
Phryganeidae								
Phryganea sayi				•			•	
Ptilostomis postica				•		•		
Polycentropodidae								
Cernotina spicata							•	
Cyrnellus fraternus		•					•	
Neureclipsis crepuscularis	•						•	
Nyctiophylax affinis							•	
Nyctiophylax celta								•
Nyctiophylax moestus						•		
Phylocentropus placidus				•	•	•		
Polycentropus crassicornis						•		
Total for site	19	6	8	16	10	14	18	17
Unique to site	11	0	1	3	3	3	7	5
Total for biotope	28			29			29	
Unique to biotope	12			14			13	

Table 1. Collection sites for Greensville County caddisflies showing distribution of species by biotopes.

TABLE II

MONTH SPECIES	April	May	June	July	August
Cheumatopsyche analis	•	•	•	•	•
Cheumatopsyche campyla					•
Cheumatopsyche ela			•		•
Cheumatopsyche harwoodi		•			•
Cheumatopsyche parentum		•			
Cheumatopsyche pasella			•		•
Hydropsyche alvata			•		•
Hydropsyche bettini			•	•	
Hydropsyche incommoda					•
Hydropsyche rossi		•			•
Hydropsyche venularis					•
Macrostemum carolinum				•	
Macrostemum zebratum			•		

Table 2. Seasonal distribution of thirteen species of the family Hydropsychidae.

TABLE III

MONTH SPECIES	8 Jun	20 Aug	29 Aug	11 Sep	16 Oct
Protoptila palina			•		
Cheumatopsyche campyla			•		
Cheumatopsyche ela	•				
Hydropsyche venularis			•		
Macrostemum zebratum				•	
Orthotrichia aegerfasciella				•	
Lepidostoma tibiale	•		•	•	
Ceraclea cancellata	•				
Ceraclea slossonae	•	•	•		
Ceraclea tarsipunctata	•				
Nectopsyche exquisita	•		•		
Nectopsyche pavida			•		
Oecetis inconspicua	•		•		
Oecetis sphyra			•		
Triaenodes flavescens			•		•
Pycnopsyche virginica					•
Chimarra obscura	•		•		
Neureclipsis crepuscularis	•				

Table 3. Seasonal distribution of eighteen species of caddisflies at Nottoway River Site 1.

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New Distributional Records for Rare and Uncommon Odonata in Virginia

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Virginia contains one of the most diverse Odonata faunas in North America when compared to other states and the various Canadian provinces. A total of 130 dragonflies and 54 damselflies have been documented in the state (Carle, 1982, 1991; Roble, 1994, 1995; Roble & Stevenson, 1996). In this paper we provide noteworthy new distributional records for selected rare and uncommon species found in the state based primarily on surveys conducted since 1991 by the zoological staff of the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH). These records are intended to supplement those contained in Carle (1982, 1991) and Roble (1994). All of our records from Caroline County and some selected new records of rare or uncommon Odonata from other counties in the state were previously reported by Roble & Hobson (1996).

For the purposes of this paper, rare species are defined as Odonata that are currently monitored by DCR-DNH (Roble, 1996). These species are typically known from fewer than a dozen sites in the state, but most are not globally rare. Although Carle (1991) recommended that the Virginia Department of Agriculture and Consumer Services grant endangered or threatened status to 13 species of dragonflies (Anisoptera), no species of Odonata are currently afforded legal protection in Virginia. Most of the uncommon species discussed below are included on the DCR-DNH Watch List, which consists of species that are not currently believed to warrant conservation attention, but which are typically known (in the case of Odonata) from 15-25 sites in the state. We have also provided new data on adult flight periods for selected species when they extend the previously known season of Virginia populations.

All of the following records are supported by voucher specimens unless noted otherwise. Collections by the authors are indicated by our respective initials. Collections by former DCR-DNH zoologists Kurt A. Buhlmann, Christopher A. Pague and Philip H. Stevenson, and contract zoologist (during May 1991) Tim E. Vogt are also indicated by their initials, as are reliable sight records reported to us by DCR-DNH botanist J. Christopher Ludwig. Mr. Vogt has also kindly permitted us to include the results of a very significant collection that he and R. Duncan Cuyler made on their own initiative on 1 October 1993. Finally, several other collectors have generously allowed us to include their unpublished records as discussed below. Most specimens obtained by the.authors have been or will be deposited in the Virginia Museum of Natural History (VMNH, Martinsville). A few will be donated to the National Museum of Natural History (USNM, Smithsonian Institution, Washington, D.C.) or retained in the DCR-DNH reference collection. Specimens collected by Tim E. Vogt are deposited in the Illinois State Museum (Springfield).

Scientific names and authors of species discussed below follow Garrison (1991) except as noted by Roble (1994) and May (1995). The common names that are used herein follow those recently adopted by the Dragonfly Society of the Americas (1996). Several of these do not correspond with the common names used previously by Carle (1991).

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Rare Species

ZYGOPTERA

Calopteryx angustipennis (Selys). Appalachian Jewelwing

Roble (1994) claimed to provide the first published records of this species from Virginia (six counties), but the population discovered in Alleghany County by Richard L. Hoffman in 1951 had been mentioned very briefly by Opler (1979), who recommended it for "Special Concern" status. Neither of these authors was aware of the second oldest collection of *C. angustipennis* in the state. Thomas W. Donnelly (pers. comm.) discovered a population of this species along Passage Creek in Shenandoah County on 16 June 1958. He subsequently verified its continued existence at this site in 1969 and 1984. Surveys conducted by SMR on 7 June 1996 confirmed that this population is still extant.

Hetaerina titia (Drury). Smoky Rubyspot

Roble (1994) reported that *H. titia* and its more common congener *H. americana* (Fabricius), the American rubyspot, occur together along the Clinch, New and Nottoway rivers in Virginia. The following two sites, which were discovered by SMR and CSH on 6 September 1995, also support both species: Lee Co.: Powell River at State Route 70, 3 km S Jonesville; Scott Co.: North Fork Holston River at U.S. Route 58/421, 1 km SE Hilton. Both of these rivers have been impacted by industrial pollution in the past (Ahlstedt, 1991; Wolcott & Neves, 1994). A recent spill (24 October 1996) from a coal waste holding pond entered a tributary of the Powell River and transported coal fines downstream into the North Fork and mainstem of the river for up to 100 km to beyond the Virginia-Tennessee border (L. Koch, U.S. Fish and Wildlife Service, pers. comm.; Silverman, 1997).

Roble (1994) overlooked a specimen of *H. titia* collected by CAP on 11 September 1991 along the Appomattox River in Amelia County. The site that he alluded to along the Nottoway River where this species had been taken by Frank L. Carle is near the County Route 653 bridge in Southampton County (F. L. Carle, pers. comm.). Both of these are previously unpublished county records for Virginia.

Enallagma pallidum Root. Pale Bluet

Roble (1994) noted that this was the only species of damselfly known from Virginia which had not been verified in the state during the preceeding 25 years. He reported that the only previous collection of *E. pallidum* was made on 26 June 1938 along the Feeder Ditch to Lake Drummond. This species was reconfirmed at Lake Drummond (City of Chesapeake) by CSH on 18 June 1996 (one male collected and another observed). Furthermore, on 11 July 1996, CSH and Doug Stannard discovered a large population of *E. pallidum* (about 175 adults observed during an abbreviated survey; 3 males collected) along Indian Creek adjacent to Northwest River Park in the City of Chesapeake, approximately 25 km SE of the Lake Drummond site.

ANISOPTERA

Aeshna mutata Hagen. Spatterdock Darner

Carle (1991) recommended this species for state endangered status because it was known from only three sites in Virginia (one each in Augusta, Craig and Highland counties). However, he failed to mention Hoffman's (1987) report of this species from Potts Pond along the Alleghany-Craig county line (which may not represent a breeding site). Division of Natural Heritage surveys have documented breeding populations of *A. mutata* at two additional sites in Augusta County (Laurel Run ponds, TEV, 1991; Loves Run Ponds, SMR, 1995). A single adult was also observed by SMR at another site in Highland County. Carle (1991) stated that the documented flight period of this species in Virginia extended from 30 May to 13 June. The records of SMR and TEV range from 25 May to 20 June.

Aeshna tuberculifera Walker. Black-tipped Darner

Carle (1982) recorded this northern species from six counties confined to western Virginia, his southernmost locality being in Russell County. Halverson (1983) added Rockingham County to the Virginia distribution of this species, indicating that it was common at his study ponds. SMR and CSH found *A. tuberculifera* to be common on 22-23 September 1993 in a beaver meadow on the Jefferson National Forest, approximately 10 km SE Norton in Scott County. It was found in association with the equally abundant *A. umbrosa* Walker (shadow darner). This record extends the range of *A. tuberculifera* one county further to the southwest in Virginia. This species reaches the southern limits of its range in western North Carolina (Cuyler, 1984).

Gomphus abbreviatus Hagen in Selys. Spine-crowned Clubtail

Carle (1982) recorded this species from six sites in five western Virginia counties, and predicted that it would eventually be found in the Piedmont region of the state. His flight dates ranged from 1 May to 6 June. On 23 May 1995, SMR discovered a population (3 males collected) along the Nottoway River at State Route 49 (Nottoway

Falls) on the Lunenburg-Nottoway county line, constituting the first record of this species in southeastern Virginia. On 22 April 1996, CSH collected a teneral female along the Nottoway River at the Chub Sandhill Natural Area Preserve (County Route 631, ca. 22 km SW Wakefield) in Sussex County. The latter site is in the Coastal Plain approximately 88 air km ESE of Nottoway Falls, and upwards of 150 river km downstream from there. Cuyler (1984) had previously documented this species in northcentral North Carolina. Both Needham & Westfall (1955) and Carle (1982) listed a 27 April record from South Carolina as the earliest known flight date for this species, but White et al. (1980) reported that an adult *G. abbreviatus* was taken on 17 April 1932 in that state.

Gomphus parvidens Currie. Piedmont Clubtail

Carle (1991) recommended this species for state threatened status because only two localities were known in Virginia (one each in Bedford and Charlotte counties). He indicated that the known flight period in the state extended from 23 May to 10 June. On 24 April 1990, CAP and Michael L. Lipford collected a teneral female along Fine Creek at County Route 711 (Fine Creek Mills) in Powhatan County. Carle (1991) and Tennessen et al. (1995) listed 29 April and 1 May as the earliest known dates for North Carolina and Alabama, respectively. White et al. (1980) listed a 5 April record from South Carolina for *G. carolinus* Carle, which is considered a junior synonym of *G. parvidens* by some authorities

Gomphus quadricolor Walsh. Rapids Clubtail

Carle (1982) recorded this species with certainty from only two sites in Alleghany and Botetourt counties in western Virginia (plus a tentative record from Montgomery Co.), but remarked that it is probably much more common in the state. The capture dates of the two records available to him were 18 May and 29 May. CAP collected one adult of this species in 1990 in extreme northern Highland County, although details of this record are unknown to the authors (specimen not seen). The USNM contains an adult male captured by O. S. Flint, Jr. on 9-10 July 1982 along the Hazel River near Boston (Culpeper Co.) in the Northern Piedmont region of Virginia.

Gomphus viridifrons Hine. Green-faced Clubtail

Carle (1991) recommended this species for state threatened status because only three localities were known in Virginia (one each in Botetourt, Floyd and Grayson counties). Carle (1982) stated that the flight period of this species in Virginia extends from 21 May (erroneously reported as 24 May in Carle, 1991) to 3 June. On 7 June 1995, CSH collected a male along the Pound River, 1.7 km N Pound in Wise County. A female was captured on 12 July 1995 by CSH and DJS along the Pound River, 0.5 km upstream of its confluence with the Russell Fork River in Dickenson County. These sites are separated by approximately 28 air km. The Pound River is impounded 1.5 km upstream of the latter collection site, forming the John W. Flannagan Reservoir. This river has also been degraded by the effects of strip mining (Jenkins & Burkhead, 1994).

Lanthus parvulus (Selys). Northern Pygmy Clubtail

Carle (1991) recommended this species for state threatened status because only two localities were known in Virginia (one each in Highland and Montgomery counties). Two additional sites were documented by CAP in Highland and Page counties during 1991 (DCR-DNH database; specimens not seen by authors).

Lanthus vernalis Carle. Southern Pygmy Clubtail

Carle (1980, 1982) recorded this species from 12 counties in western Virginia, with flight dates ranging from 13 May to 14 July. Our surveys have documented *L. vernalis* at the following additional sites: Bath Co.: Bubbling Springs, George Washington National Forest, 8 May 1995, SMR and Michael W. Donahue; Montgomery Co.: hillside seepage along County Route 641, 3.5 km NW Montgomery, 10 May 1994, SMR (teneral); Russell Co.: 3.3 km NE South Clinchfield, 14 June 1996, SMR (sight record believed to be this species rather than *L. parvulus*). The latter two constitute new county records.

Ophiogomphus alleghaniensis Carle. Allegheny Snaketail

Carle (1982, 1991) reported that this species was known in Virginia only from nymphal collections made at one site in Giles County that was threatened by habitat alteration. Consequently, he recommended that it be granted state endangered status (Carle, 1991). Terwilliger & Tate (1995) listed its status in Virginia as probably extirpated. Fortunately, another Virginia population was recently discovered by Tim E. Vogt and R. Duncan Cuyler, who collected a single nymph on 1 October 1993 from the Little River in Floyd County (T. E. Vogt, pers. comm.). The specimen was successfully reared to maturity and the adult that emerged was identified by Kenneth J. Tennessen (T. E. Vogt, pers. comm.). This collection site also supports the only known Virginia population of the globally rare mountain river cruiser, *Macromia margarita* Westfall (Carle, 1991).

Ophiogomphus howei (Bromley). Pygmy Snaketail

This rarely collected species was originally discovered in Virginia by Kennedy & White (1979), who described the nymph based on material collected in the New River. Opler (1979) proposed that its status in Virginia be listed as special concern, whereas Carle (1991) recommended *O. howei* for state endangered status. Carle (1982, 1991) knew of only two collection sites along the New River in Virginia (one each in Carroll and Grayson counties), although he found more than 700 exuviae on a single date at the latter site. In May of 1992, KAB and Judy Jacobs (U.S. Fish and Wildlife Service) collected exuviae of *O. howei* (all identifications by Clark N. Shiffer) at nine bridge crossing sites along the river extending from the U.S. Route 21/221 bridge near the North Carolina-Virginia border downstream (north) to Ivanhoe in Wythe County (Buhlmann, 1992). Subsequently, Tim E. Vogt and R. Duncan Cuyler collected 10 nymphs (two reared to adult) from the Little River site in Floyd County where the preceding species was taken (T. E. Vogt, pers. comm.). Their collections (all made on 1 October 1993) also documented the presence of *O. aspersus* Morse, the brook snaketail, and *O. rupinsulensis* (Walsh), the rusty snaketail, making it one of very few sites in North America where four members of this genus occur syntopically (T. E. Vogt, pers. comm.). Carle (1982) had previously recorded only *O. aspersus* at this site.

Stenogomphurus consanguis (Selys). Cherokee Clubtail

Carle (1991) reported that this rarely collected species reaches the northern limit of its restricted global distribution in extreme southwestern Virginia, where it was known from a total of two sites in Scott and Washington counties, respectively. He recommended that it be designated a state endangered species and speculated that many populations had been lost within its limited range in the southern Appalachians due to factors such as the creation of impoundments and water quality degradation. Surveys by DJS in June of 1995 resulted in the discovery of *S. consanguis* at five additional sites in Scott County and two new sites in Washington County. Several specimens that he collec-ted on 16 June extend the Virginia flight period one day past that listed in Carle (1991). The range of this species was extended north into Russell County by SMR in 1996, when he documented a population near the Clinch River north of Lebanon. Our status survey for this species will continue through at least the 1997 field season, after which time a more complete account of its distribution in Virginia will be prepared.

Stenogomphurus rogersi (Gloyd). Sable Clubtail

Carle (1982) reported this rarely collected species from two sites in southwestern Virginia (both in Washington County), as well as one site in northeastern Virginia (Spotsylvania County). Donnelly (1994) and Flint (1996) recently reported (as *Gomphus rogersi*) that a single female specimen was taken in a Malaise trap in Essex County. During the June 1996 status survey for *S. consanguis*, SMR documented populations of *S. rogersi* at the following new sites: Smyth Co.: Carlock Creek, 7.5 km SE Saltville (7 males); Washington Co.: unnamed tributary to South Fork Holston River, 1.5 km SE Lodi (1 male). Three additional populations of *S. rogersi* were discovered by Frank L. Carle in 1995 in southwestern Virginia (F. L. Carle, pers. comm.), bringing the total number of documented sites in the state to nine.

Stylurus scudderi (Selys). Zebra Clubtail

Carle (1982) knew of only one record for this species in Virginia, from an unspecified locality in Roanoke County. John Michalski (pers. comm.) collected one emerging male on 13 July 1988 along the east bank of the New River downstream of the U.S. Route 58/221 bridge, 9.5 km E Independence in Grayson County. Numerous emerging *S. spiniceps* (Walsh), the arrow clubtail, were also collected at this site on that date. DCR-DNH biologists have not encountered this species in Virginia.

Cordulegaster diastatops (Selys). Delta-spotted Spiketail

Carle (1983) recognized that this name applied to two sibling species and described *Zoraena* (treated as a subgenus of *Cordulegaster* by most authors) *bilineata*, the brown spiketail, which applied to the more southern form. The only valid Virginia record of *C. diastatops* was thus restricted to an adult male specimen that he collected on 4 June 1977 at a site in Highland County that harbors many northern species of Odonata at or near the southern limits of their ranges (Carle, 1982, 1983). The second Virginia specimen (adult female) of *C. diastatops* was captured by CSH on 23 May 1995 on the Wallops Flight Facility, 2.2 km NE Wattsville in Accomack County on the Delmarva Peninsula. This record was quite unexpected because this species has been documented in Maryland only in the extreme western part of the state (R. L. Orr, pers. comm.) and it is apparently unrecorded in Delaware (Carle, 1983; H. B. White, pers. comm.). May & Carle (1996) reported this species from nine counties in New Jersey, including the southernmost two (Cumberland and Cape May).

The Accomack County site is a forested seepage wetland containing shallow water in a dendritic branching pattern, with mucky seepage pools and a silty, sand-bottomed stream. This habitat also supports populations of the uncommon damselflies *Amphiagrion saucium* (Burmeister), the eastern red damsel, and *Ischnura prognata* (Hagen), the furtive forktail.

Cordulia shurtleffi Scudder. American Emerald

Carle (1982) recorded this northern species from three sites in Bath and Highland counties in western Virginia. Halverson (1983) indicated that it was common at his study ponds in Rockingham County. Surveys by TEV on 25 May 1991 documented the first records of *C. shurtleffi* from Augusta County. It has subsequently been found by SMR at two sites on the George Washington National Forest in this same county. The earliest Virginia flight date listed in Carle (1982) was 10 June.

Epitheca costalis (Selys). Stripe-winged Baskettail

Carle (1982, 1991) stated that this species (reported as *Tetragoneuria costalis*) was known from only three sites in Virginia, namely Great Falls (Fairfax County), the Great Dismal Swamp (City of Suffolk) and Seashore State Park (City of Virginia Beach). A second locality in the City of Virginia Beach was confirmed on 21 May 1991 when TEV collected this species at Black Gut, 0.4 km W Sandbridge.

Tramea onusta Hagen. Red-mantled Saddlebags

Carle (1982) recorded this species only from Charles City and Montgomery counties in Virginia, with flight dates ranging from 20 May to 12 June. As noted previously by Roble & Hobson (1996), Carle determined that Matta's (1978) records for this species from southeastern Virginia were based on misidentified specimens of *T. carolina* (Linnaeus), the Carolina saddlebags. On 2 July 1991, CAP collected a male at Green Pond, Big Levels Wildlife Management Area on the George Washington National Forest in Augusta County.

Uncommon Species

ZYGOPTERA

Archilestes grandis (Rambur). Great Spreadwing

Roble (1994) knew of only four county records for this species in Virginia. Two new county records are now available. An adult was observed but not collected in the fall of 1996 by CSH in Henrico County west of the City of Richmond corporate limits. Michael W. Donahue collected an adult male *A. grandis* in the Kelly Flats area of the Jefferson National Forest in Giles County on 30 October 1996 (specimen in VMNH), which also represents a new late flight date for this species in Virginia.

Lestes congener Hagen. Spotted Spreadwing
Lestes eurinus Say. Amber-winged Spreadwing

Roble (1994) reported these uncommon species from seven and eight counties, respectively, in Virginia. In each case, all but one of the confirmed counties lies in the western portion of the state. Flint (1996) added records of *L. congener* from Clarke County. Both of these species were collected on 11 July 1995 by CSH and DJS at Mullins Pond on Pine Mountain, Jefferson National Forest in Dickenson County (new county records). The aurora damsel, *Chromagrion conditum* (Hagen), and *Amphiagrion saucium*, two other locally distributed damselfly species that had previously been documented in this county (Roble, 1994) were also present at this pond.

Lestes forcipatus Rambur. Sweetflag Spreadwing

A population discovered in Bath County on 14 July 1995 by SMR is an addition to the county records listed in Roble (1994).

Lestes inaequalis Walsh. Elegant Spreadwing

A sight record obtained on 2 June 1994 by CSH in York County was omitted by Roble (1994) from the list of cities and counties with confirmed records.

Amphiagrion saucium (Burmeister). Eastern Red Damsel

Recent additions to the county records listed in Roble (1994) and Flint (1996) are Accomack (CSH), Frederick (SMR), Floyd (SMR), Lee (CSH), Shenandoah (SMR) and Smyth (DJS).

Ischnura prognata (Hagen). Furtive Forktail

Stevenson et al. (1995) demonstrated that this species was more common in Virginia than had been suggested by Roble (1994), who knew of only one historical and one recent record. They found *I. prognata* at seven new sites during 1995 alone. Flint (1996) reported specimens taken during Malaise trapping in Essex County. Our surveys in 1996 documented this species at the following new sites: Greensville Co.: 2 km NNE Claresville, 8 August 1996, SMR; Sussex Co.: Chub Sandhill Natural Area Preserve, 22 April 1996, CSH, SMR and DJS; City of Suffolk: property adjacent to Suffolk Regional landfill, north of U.S. Route 58, 9 May 1996, CSH; Great Dismal Swamp National Wildlife Refuge, Jericho Ditch jct. with Lynn Ditch, 22 May 1996, CSH (sight record); City of Chesapeake: North Landing River Preserve (The Nature Conservancy), 29 May 1996, CSH. Our April collection constitutes a new early flight date for this species in Virginia.

ANISOPTERA

Tachopteryx thoreyi (Hagen). Gray Petaltail

Carle (1982) recorded this large, primitive dragonfly from 13 Virginia counties, with flight dates ranging from

22 May to 3 August. Roble & Hobson (1996) documented it at four sites in Caroline County and Flint (1996) added a record for Essex County. The following constitute new county records: Dickenson Co.: four sites on the Jefferson National Forest (Dutten Gap, Maynard Ridge, Mullins Pond and Skegg Branch), 9 June-12 July 1995, CSH and DJS (voucher specimens collected at two sites); Lee Co.: southwest of Falling Water Gap near the Kentucky state line, 9 August 1995, JCL (sight records); Lunenburg-Nottoway Co. line: Nottoway Falls, 23-26 May 1995, SMR and DJS; Northumberland Co.: Bushmill Stream Natural Area Preserve, 9 May 1996 (nymph), SMR; Page Co.; 11 km west of Luray, 14 July 1979, G. F. Hevel (USNM); Shenandoah Co.: Powells Fort Camp, George Washington National Forest, 7 June 1996, SMR; Wise Co.: Jefferson National Forest near Pine Mountain Tunnel, 10 June 1995, CSH and William H. Moorhead (sight record).

The nymph that was collected in Northumberland County has been kept alive for nearly a year. It has been housed in a small, covered plastic bowl containing a few decaying, deciduous leaves and approximately 5 mm of water (room temperature with no aeration) and fed only occasionally (mostly wood roaches). The hardiness and semi-terrestrial nature of this specimen, which continues to grow despite minimal care, is remarkable for an aquatic insect. Dunkle (1981) observed that captive larvae preferred to remain in water when young, but chose a mud substrate over water at an older age. In the wild, larvae live between or under leaves near the upper edge of seepage areas (Dunkle, 1981).

Boyeria grafiana Williamson. Ocellated Darner

Carle (1982) reported this species from 18 sites in 13 counties in western Virginia. New county records are: Scott Co.: Staunton Creek at County Route 653, 21 September 1993, SMR and CSH; Smyth Co.: Big Tumbling Creek, Clinch Mountain Wildlife Management Area, 19 August 1992, SMR.

Gomphaeschna furcillata (Say). Harlequin Darner

Roble & Hobson (1996) recorded this early spring species from Caroline County and noted that it was considerably more common in Virginia than suggested by the records in Carle (1982). Flint (1996) reported this species from Essex County. New county records that we have documented are from Augusta (SMR), Fairfax (CSH) and York (DJS). Matta (1978) recorded *G. furcillata* from the City of Suffolk, although Carle (1982) did not include these records in his compilation. On 17 April 1996, SMR and DJS observed this species in abundance along Lynn and Washington ditches in the Great Dismal Swamp National Wildlife Refuge (City of Suffolk). Division of Natural Heritage zoologists have also documented several populations of *G. furcillata* in the City of Virginia Beach at sites other than those listed in Carle (1982). Carle (1982) stated that the flight season in Virginia ranged from 8 April to 25 May. Our latest record was obtained on 31 May.

Erpetogomphus designatus Hagen in Selys. Eastern Ringtail

Carle (1982) reported this species from 10 counties in Virginia. Several adults were captured by SMR and DJS on 23 August 1995 along the South Fork Shenandoah River near Limeton in Warren County at the site of the newly created Shenandoah River/Andrew Guest State Park. This species was also recorded along the North Fork Shenandoah River at Strasburg in Shenandoah County on 2 July 1977 (T. W. Donnelly, pers. comm.). These are the first records of *E. designatus* from the Shenandoah Valley. This species was also observed by SMR along the Hazel River in Culpeper County (county record). A specimen observed in a Richmond (city) office building on 8 June 1995 and captured the following day (DJS) constitutes a newly early flight date for the state.

Gomphus lineatifrons Calvert. Splendid Clubtail

Carle (1982) recorded this species from 11 counties in western Virginia, with flight dates ranging from 21 May to 27 June. New county records that we have documented in the extreme southwestern corner of the state are: Dickenson Co.: Pound River at site of *G. viridifrons* locality discussed above, 12 July 1995 (DJS, sight record); Scott Co.: Copper Creek at State Route 71, 11 June 1995 (CSH and W. H. Moorhead); Washington Co., Smith Creek, 14 June 1995 (DJS); Wise Co.: Pound Reservoir, 14 July 1995 (CSH and DJS, sight record).

Gomphus vastus Walsh. Cobra Clubtail

Carle (1982) recorded this species from 10 counties in central and western Virginia. Louton (1982) added a record from Scott County. During June of 1995, DJS also documented this species in Scott County when he found it at two sites (Cove Creek and an unnamed tributary of Copper Creek).

On 28 May 1993, CSH collected an adult female at Big Pond along the Appalachian Trail in Giles County, although this individual was probably a vagrant.

Hagenius brevistylus Selys. Dragonhunter

Carle (1982) recorded this large gomphid from 16 counties in Virginia, with flight dates ranging from 27 May to 2 September. Roble & Hobson (1996) reported it from Caroline County. Additional DCR-DNH surveys have nearly doubled the number of counties from which *H. brevistylus* has been documented in Virginia, revealing that this species is relatively common in the state. These new county records are: Albemarle Co.: James River (CSH, sight record); Appomattox Co.: Appomattox River (SMR); Brunswick-Dinwiddie Co. line: Nottoway River (CSH and SMR); Carroll Co.: Big Reed Island Creek (SMR); Grayson Co.: New River (SMR et al.); Greensville Co.: Fontaine (= Fountains) Creek (KAB and CAP); Highland Co.: Bullpasture River (SMR, sight record); Isle of Wight Co.: Blackwater River (SMR, sight record); Lunenburg-Nottoway Co. line: Nottoway Falls (SMR and DJS) and County Route 627 bridge (PHS); Lee Co.: Powell River and vicinity (SMR and CSH, sight records) and Indian Creek (SMR, larvae); Nottoway Co.: Little Nottoway River (PHS); Patrick Co.: Dan River (SMR and CSH, sight records); Shenandoah Co.: Passage Creek (SMR; first recorded here in 1958 by Thomas W. Donnelly); Sussex Co.: Nottoway River (PHS). Our latest record for this species is 6 September.

Progomphus obscurus (Rambur). Common Sanddragon

Carle (1982) reported this species from approx-imately 20 sites in 12 scattered counties in Virginia. Roble & Hobson (1996) added records from Caroline County. Additional county records documented during DNH surveys are: Chesterfield Co.: Swift Creek, Pocahontas State Park (SMR and CSH); Dickenson Co.: Russell Fork River (CSH); Isle of Wight-Southampton Co. line: Blackwater River (SMR); Lunenburg-Nottoway Co. line: Nottoway Falls (SMR and DJS); Prince William Co.: South Fork Quantico Creek, Prince William Forest Park (PHS). The USNM also contains a male collected recently in Prince William Forest Park.

Stylogomphus albistylus (Hagen in Selys). Least Clubtail

Carle (1982) reported this species from 14 counties in western Virginia, extending as far west as Washington County. New county records that we have documented in the southwestern corner of the state are: Bland Co.: Little Wolf Creek (CSH); Dickenson Co.: Pound River (DJS and CSH) and Upper Twin Branch (CSH and DJS); Scott Co.: Cove Creek (DJS). Jerry A. Louton (pers. comm.) previously collected nymphs of this species in Copper Creek, Scott County, but this record does not appear on the county range map in Louton (1982). In June of 1995, DJS recorded *S. albistylus* at three additional sites in Washington County. Thomas W. Donnelly (pers. comm.) documented *S. albistylus* along Passage Creek in Shenandoah County on 17 June 1969, which is another county record. We have also found this species at additional sites in several of the counties listed in Carle (1982), indicating that it is relatively common in Virginia.

Stylurus spiniceps (Walsh). Arrow Clubtail

Carle (1982) reported this species from eight counties in Virginia, with flight dates ranging from 19 June to 4 September. New county records documented during DNH surveys are: Albemarle Co.: Mechums River near Owensville, 18 October 1993, SMR and CSH; Lee Co.: Powell River at Route 833, 4 September 1995, CSH and SMR; Northampton Co.: Hog Island, 11 July 1990, CAP. SMR and CSH have also found this species at sites along the Hazel River (Culpeper Co.) and Little River (Floyd Co.) other than those listed in Carle (1982). Our October record not only represents a new late date for Virginia, but it is apparently the latest published record for *S. spiniceps* rangewide. The latest date known to Needham & Westfall (1955) was 5 October, whereas Carle (1982) listed a 12 October record from Pennsylvania.

Cordulegaster erronea Hagen in Selys. Tiger Spiketail

Roble & Hobson (1996) remarked that this species is more common in Virginia than previously believed, and added Caroline and York counties to the records listed in Carle (1982). Additional new county records are from the following localities: Dickenson Co.: Headwaters of Little Fork, Dutten Gap on the Jefferson National Forest, 11 July 1995, DJS and CSH; Breaks Interstate Park, 29 June 1991, John M. Anderson (VNMH); Floyd Co.: Buffalo Mountain, 17 July 1993, JCL (sight record). The former site is also inhabited by *Tachopteryx thoreyi*. The latter site was recently purchased by the Virginia Department of Conservation and Recreation and added to the state natural area preserve system. The USNM contains a female specimen collected by Nancy E. Adams on 13 August 1993 in Prince William Forest Park, Prince William County, which also constitutes a new county record.

Macromia taeniolata Rambur. Royal River Cruiser

Carle (1982) recorded this large species from ten counties in Virginia. A new county record was documented on 1 September 1992 when KAB collected an adult female near the Blackwater Ecologic Preserve, 6 km SSW Zuni, Isle of Wight County.

Neurocordulia obsoleta (Say). Umber Shadowdragon

This crepuscular species is undoubtedly more common in Virginia than previous records (6 sites in 6 counties, Carle, 1982) indicate, owing to the difficulty of observing and capturing rapidly flying adults at twilight. The following are new county records: Isle of Wight Co.: Blackwater River at County Route 614 bridge, 1 km W

Zuni, 26 May 1995, CSH; Blackwater River at Antioch Pines Natural Area Preserve, 5 km SSW Zuni, 21 May 1996, SMR and Richard L. Hoffman; Lunenburg-Nottoway Co. line: Nottoway Falls, 23 May 1995 (SMR) and 26 May 1995 (SMR and DJS). One of the specimens collected at the Antioch site was captured shortly after dark when it was attracted to a blacklight that was operating on a high bank above the river. This species was most common at the Nottoway Falls site, where approximately 50 patrolling males were observed before dusk on 26 May 1995. Three days earlier, a mated pair was collected on a shaded rock boulder bordering the river at 1945 h, nearly an hour before dusk. The earliest Virginia flight date listed in Carle (1982) was 2 June.

Somatochlora linearis (Hagen). Mocha Emerald

Carle (1982) recorded this species from nine scattered counties in Virginia, ranging as far west as Montgomery County. Roble & Hobson (1996) reported *S. linearis* from Caroline County based on sight records. We have also documented it in the following new counties: Chesterfield (SMR), Scott (SMR) and Surry (SMR). The single male specimen from Scott County, which was collected in a high elevation (835 m) headwater stream above Bark Camp Lake, is blackish and approximately 15% smaller than several coppery specimens captured in a blackwater swamp in Surry County.

Brachymesia gravida (Calvert). Four-spotted Pennant

Carle (1982) recorded this species only from Lancaster County and the City of Virginia Beach. Our surveys have revealed that it is more common and widespread in coastal areas of Virginia. New city and county records are: Accomack Co.: Wallops Island (DJS and CSH, specimen destroyed); Fairfax Co.: Fort Belvoir Military Reservation (CSH, sight record); Northampton Co.: Hog Island (KAB); Northumberland Co.: Hughlett Point Natural Area Preserve (SMR); York Co.: Camp Peary Military Reservation (SMR and CSH, sight record); City of Chesapeake: Northwest River (JCL and CSH, sight records); City of Newport News: Fort Eustis Military Reservation, (DJS and SMR, sight records). Additional populations have also been documented by several DNH biologists in Virginia Beach.

Celithemis fasciata Kirby. Banded Pennant

Roble & Hobson (1996) added Caroline County to the 11 Virginia counties listed by Carle (1982). Additional city and county records documented during DNH surveys are: Augusta Co.: George Washington National Forest (SMR); Greensville Co.: 5.5 km SE Bryants Corner (SMR) and Fontaine Creek (KAB and CAP); Isle of Wight Co.: Cat Ponds (CAP); Lee Co.: Keokee Lake (CSH, sight record); Nottoway Co.: Fort Pickett Military Reservation (CSH); Wise Co.: Pound Reservoir (CSH and DJS, site records); City of Virginia Beach: Fort Story Military Reservation, many records (KAB, DJS, SMR, CSH and David A. Young).

Erythrodiplax minuscula (Rambur). Little Blue Dragonlet

Roble & Hobson (1996) added three counties to the six city and county records listed for Virginia by Carle (1982), and noted that this species is fairly common in the southeastern portion of the state. The Grayson County specimen collected by SMR was taken in a boggy headwater seepage at 4800 feet (1463 m) near the base of Mount Rogers. Additional county records documented by DNH surveys, but not reported by Roble & Hobson (1996) are: Fairfax Co.: Fort Belvoir Military Reservation (CSH, sight record); Greensville Co.: Fontaine Creek (KAB and CAP); Isle of Wight Co.: property adjacent to Blackwater Ecologic Preserve (SMR and KAB); Nottoway Co.: Fort Pickett Military Reservation (CSH); Surry Co.: near Blackwater River 10 km E Waverly (SMR and CSH).

Libellula axilena Westwood. Bar-winged Skimmer

Roble & Hobson (1996) reported this species from Caroline County and remarked that it is fairly widespread in Virginia. Additional new county records (to the ten listed in Carle, 1982) that we have documented are from Accomack (SMR) Augusta (SMR), Bath (SMR), Fairfax (CSH), Isle of Wight (SMR), Scott (SMR) and York (DJS and SMR) counties.

Sympetrum ambiguum (Rambur). Blue-faced Meadowhawk

Roble & Hobson (1996) remarked that this species was more common and widespread in the Coastal Plain of Virginia than suggested by the records in Carle (1982). They alluded to nine additional new city and county records in this physiographic province that were not specifically mentioned in their paper. These records are as follows: Accomack Co. (SMR, CSH and DJS), Fairfax Co. (CSH), Isle of Wight Co. (SMR), King George Co. (KAB), Northampton Co. (SMR), Prince George Co. (SMR), Surry Co. (SMR), York Co. (DJS, KAB, CSH and SMR) and the City of Hampton (CSH). Flint (1996) recently reported this species from Clarke County based on two male specimens collected in a Malaise trap between 29 September and 25 October. Carle (1982) stated that the flight season of *S. ambiguum* in Virginia extends from 4 July to 12 October. Our records range from 24 June to 13 October.

Sympetrum semicinctum (Say). Band-winged Meadowhawk

Carle (1982) recorded this species from nine counties in western Virginia, ranging as far west as Tazewell County. An adult female was collected by SMR and CSH on 22 September 1993 in Scott County at the site listed above for *Aeshna tuberculifera*

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An Abnormal Variant of Sweetgum (*Liquidambar styraciflua* L.) from Caroline County, Virginia

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Leaves of individuals of *Liquidambar styraciflua* L. (sweetgum) are predominantly 5-lobed, occasionally 7-lobed or 3-lobed (Radford et al., 1968; Cocke, 1974; Grimm, 1983; Duncan & Duncan, 1988). The tips of the lobes are acute and leaf margins are serrate, rarely entire.

In 1991, I found a seedling (2-3 yr old) that I tentatively identified as a specimen of *Liquidambar styraciflua*. The specimen occurs in a 20 acre section of deciduous forest located between U.S. Route 1 and Waverly Drive, 3.2 km south of Ladysmith, Caroline County, Virginia. The seedling was found at the middle of a 10% slope. Dominant trees on the upper slope include *Quercus alba* L., *Q. falcata* Michx., and *Liriodendron tulipifera* L. On the lower slope, *L. styraciflua*, *Q. phellos* L., and *Acer rubrum* L. are dominant. Leaves of the seedling were 3-lobed, seemed smaller than normal for older seedlings of *L. styraciflua* and the tips were broadlly rounded rather than acute. I reexamined the plant in the winter and early fall of 1996 to verify the identification and to measure leaf characteristics at the early sapling stage for this atypical specimen and for individuals in three height classes of normal sweetgum. Identification was made using Grimm (1983) and by direct comparisons with typical sweetgum saplings and mature trees and with other lobe-leaved species in the area (e.g., *Acer rubrum* L. and *Platanus occidentalis* L.). A voucher specimen (summer condition) has been deposited in the Randolph-Macon College herbarium.

Height of the specimen in late August 1996 was 116 cm and based on observations of terminal bud scars and the year in which it was first seen, the plant is estimated to be 7-8 yr of age. Fifty leaves were measured (cm) for maximum leaf blade width, leaf blade length, and petiole length. The number of lobes per leaf and the state of the leaf margins (entire, remotely serrate, serrate) were also recorded.

Similar measurements were made from surrounding plants in three height classes: early sapling, 61-134 cm; large seedlings, 10-23 cm; and small seedlings (mostly first year), 3-8.5 cm. All of the small seedlings were within 5 meters of the atypical specimen and most of the large seedlings and saplings were within 10 meters. The greatest distance between any two plants was 70 meters. All of the plants measured were in dense to moderate shade. In the seedling classes, three leaves were measured from each of ten plants (n = 30 leaves). In the sapling class, counts of leaf lobes and observations of lobe tips and leaf margins were made from ten leaves from each of 20 plants (n = 200 leaves) while five plants were used for the other measurements (n = 50 leaves). Means (cm) for maximum leaf blade width (BW), blade length (BL), and petiole length (PL) for each of the size classes and the atypical specimen were: small seedlings (BW 2.4; BW, 2.4; PL, 1.0); large seedlings (5.7, 4.5, 2.4); early saplings (9.6, 7.3, 5.9); atypical saplings (5.0, 4.5, 3.4). The percentage of leaves with 3, 5, and 7 lobes in each class and the unusual specimen was: small seedlings (3 lobes, 100%,; 5 lobes, 0%; 7 lobes, 0%); large seedlings (10%, 90%, 0%); young saplings (0.5%, 92%, 7.5%); atypical specimen (82%, 18%, 0%). All of the leaves in all size classes were serrate and the lobe tips were acute. In the atypical specimen the leaves were mostly entire, occasionally remortely serrate and the lobe tips were broadly rounded, rarely truncate or obtuse. Silhouettes of leaves from the the atypical and normal specimens are shown in Figure 1. They were produced by photocopying dried and pressed leaves. The unusual sapling most closely resembles the seedling stages in most of the characters examined and thus may be simply retaining seedling characteristics, however, it is quite distinct with respect to the shape of the lobe tips and the predominantly entire leaf margins. Growth rates were estimated by measuring distances between terminal buds and terminal bud scale scars and rates calculated as cm per year. The growth rate for the atypical specimen was 15.6 cm per yr which is comparable to the mean growth rate from 10 young saplings (15.0). The plant will be reexamined in later years to determine if the unusual traits are maintained.

A horticultural cultivar of *L. styraciflua* with rounded leaf lobes is known as 'Rotundiloba' (Dirr 1990). Dirr indicated that it had been incorrectly listed as 'Obtusifolia' in a 1983 edition of his work. He described the summer leaves as lustrous dark green above and the typical fall color as reddish-purple. Measurements of leaf size or other leaf characteristics were not given. Fall color for the sapling I have described was yellow (1996) and the summer leaves were glossy green; however this was also true of all other saplings in the study site. The fall color and summer appearance of the leaves of many tree species are subject to environmental variation and Dirr reported yearly variation in 'Rotundiloba' from reddish-purple to yellow. The summer and fall appearance of the leaves of the cultivar are within the range of normal variation for *L. styraciflua*. The cultivar is known to be sterile. The history of 'Rotundiloba' is not explained in Dirr (1990) but the

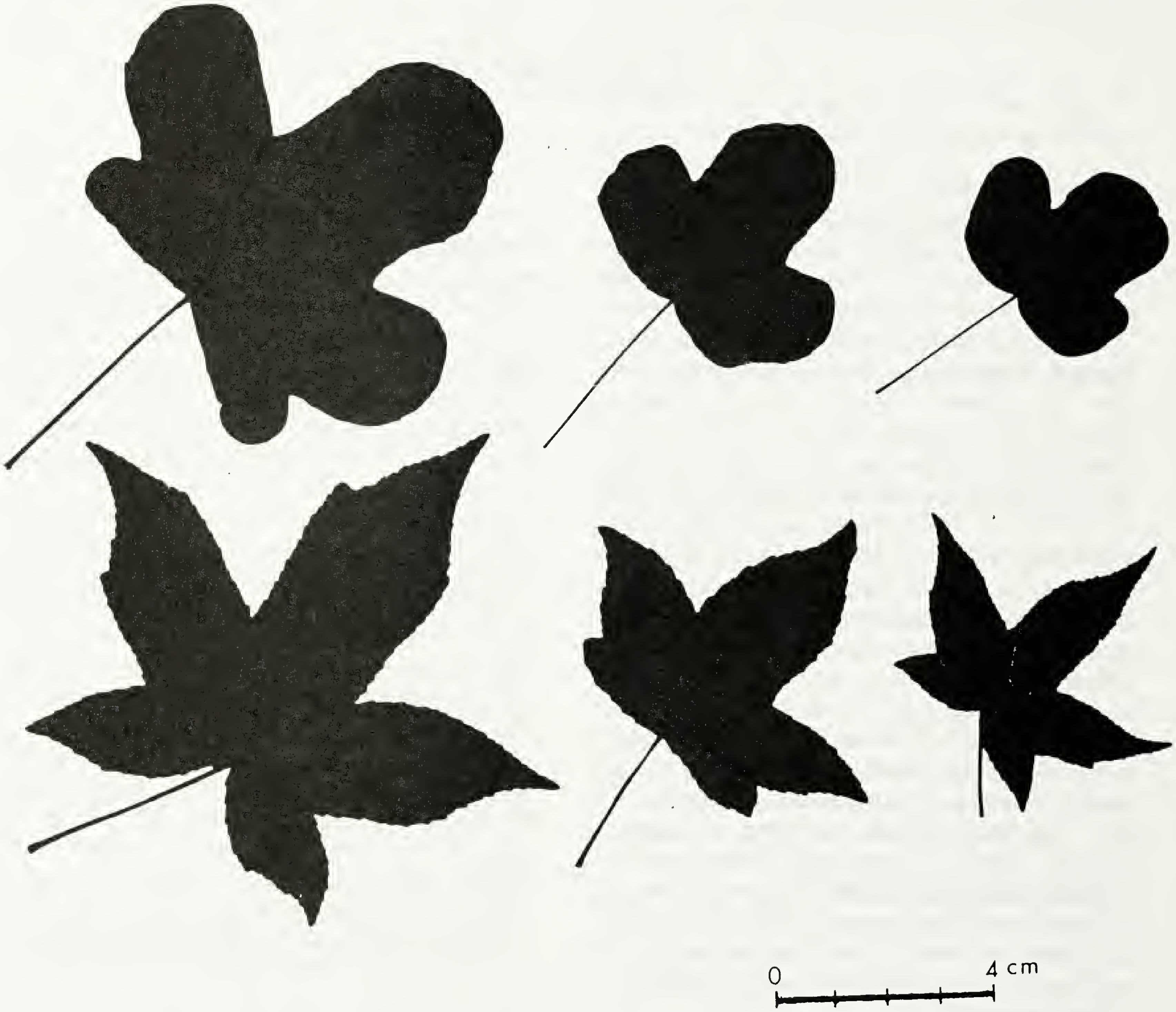

Figure 1. Leaves from an atypical sapling of *Liguidambar styraciflua* from Caroline County, Virginia (top) and from typical saplings in the same height class (bottom).

description seems to be based on a single tree now growing on the campus of North Carolina State University (Raleigh) which was discovered in the wild in North Carolina in 1930. Apparently the cultivar is not being asexually propagated for the horticultural trade. Taxonomically, 'Rotundiloba' and the specimen I have described might best be treated as a single form. I have found no reports of the round-lobed forms from natural habitats in Virginia. It is possible that round -lobed variants of *L. styraciflua* result from a single recurring mutation with pleiotropic effects. Dirr (1990) reported a branch reversion to the typical leaf shape in 'Rotundiloba' so the mutation may be somatic.

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Ecological Notes on the Amphibians and Reptiles of the Naval Surface Warfare Center, Dahlgren Laboratory, King George County, Virginia

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The Virginia Department of Conservation and Recreation, through its Division of Natural Heritage was contracted in 1991 to conduct a natural heritage inventory of the Naval Surface Warfare Center, Dahlgren Laboratory (NSWCDL), in King George County, Virginia. The goal of the inventory was to identify, through field surveys, all of NSWCDL's important natural heritage resources. By definition, this included those sites supporting unique or exemplary natural communities, rare plants and rare animals, and other significant natural features (Buhlmann & Belden, 1992). We summarize here our observations on the amphibian and reptile species encountered in the course of this project.

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King George County has not been well-explored herpetologically. Reed (1957) published several initial observations and Hill & Pierson (1986) listed the species they observed in Caledon State Park, located 12 km west of NSWCDL along the Potomac River. Tobey (1985) and Mitchell (1994) included all known records on their distribution maps. Some of the observations reported here represent the first county records supported by voucher specimens.

STUDY SITE

NSWCDL is located in King George County, Virginia and lies entirely within the northern Coastal Plain physiographic region. NSWCDL has been operated by the U.S. Department of the Navy since 1919. The facility covers approximately 1758 ha (T. Wray, personal communication). It is bordered by the Potomac River on the east. Narrow coastal beach scrub habitat exists along the Potomac River. Upper Machodoc Creek divides NSWCDL into two sections. The northern portion (Mainside) is bordered by U.S. Rt. 301 on the north and the town of Dahlgren on the west. Mainside is further divided by north-south flowing Gambo Creek. The southern portion is called Tetotum Flats and includes a wetland known as Black Marsh. Gambo Creek and Black Marsh are extensive freshwater/brackish tidal marsh systems. Forested habitat provides buffers for much of the these aquatic systems. Natural terrestrial vegetation throughout the area includes loblolly pine (*Pinus taeda*) and oak-dominated hardwood forests.

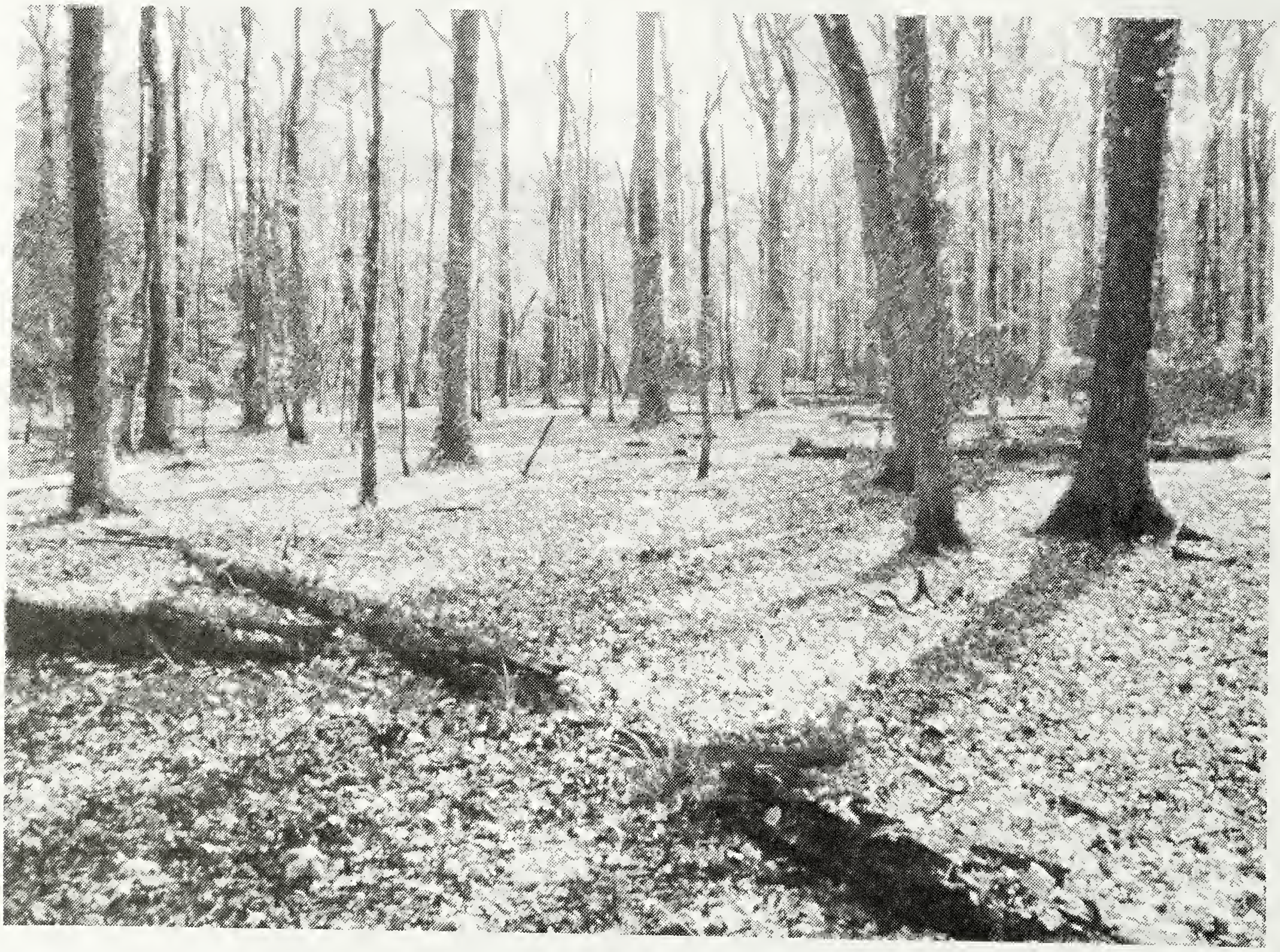

Figure 1. Forested wetland swale in the northwestern corner of NSWCDL, King George County, Virginia. Photograph by K. A. Buhlmann, 6 November 1991.

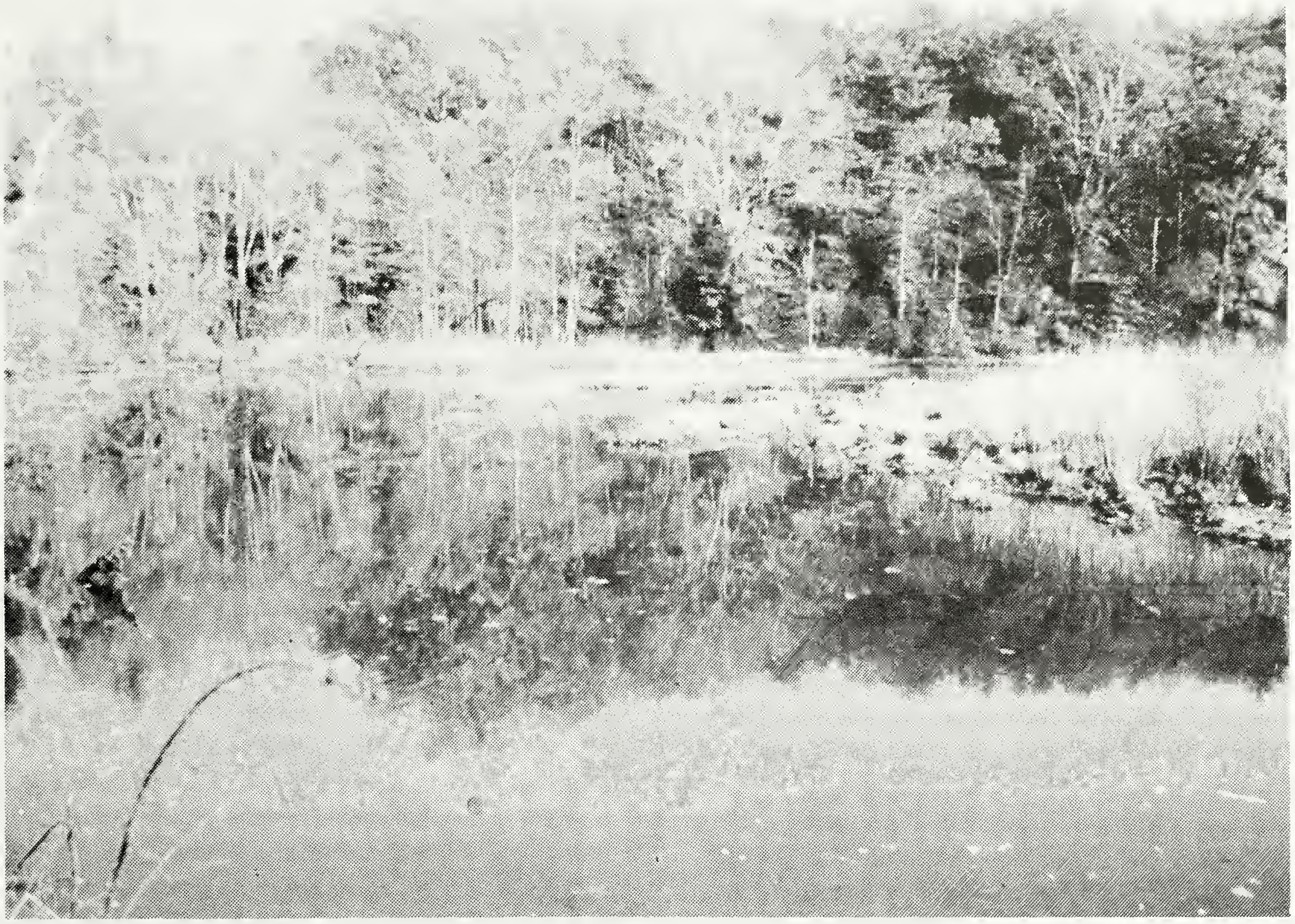

Figure 2. Gambo creek on NSWCDL, King George County, Virginia. Photograph by K. A. Buhlmann, 6 November 1991.

The topography of NSWCDL is flat with elevations ranging from 0 to 10 m above sea level. The entire area is underlain by one soil association, the Tetotum-Bladen-Bertie. These soils are deep, moderately well drained to poorly drained and have a clay loam, sandy clay loam, or clay subsoil. This soil type is typically found in broad, low lying areas (Isgrig & Strobel, 1974).

Average annual temperature is 13.9° C. Temperatures above 42° C and below -17° C are rare (Isgrig & Strobel, 1974). Maximum temperatures above 32° C occur about 30 days per year. Some mild periods occur in winter and occasional periods of dry, mild weather replace warm, humid air in summer. Annual precipitation averages 100 cm. Average monthly precipitation ranges from 11.7 cm in July to 6.1 cm in February and November. During the summer months of 1991, the area experienced periods of drought.

NSWCDL has been altered extensively by military use and approximately 40% is considered developed or residential (TES, Inc. 1978). Most of the development occurs primarily in the area immediately north of Upper Machodoc Creek. Most of NSWCDL had been cleared of timber in the past and large cleared areas are maintained currently for an airplane runway on the Mainside section and an explosives-use area in Tetotum Flats. Stands of planted loblolly pine forests and two impoundments occur on the facility. Disturbances such as explosives detonation are ongoing.

An area of forested wetland swales is located in the northwestern portion of NSWCDL. The swales drain south to the north end of the airport runway. The swales border Co. Rt. 614 on the west and extend northward beyond NSWCDL boundaries, across U.S. Rt. 301, and onto Mathias Point Neck. These wetlands were the focus of intensive field surveys during this study because they were believed to contain the greatest biodiversity.

The forested wetland swale consists of several seasonally-flooded, parallel low troughs in flat topography. The swale is further sub-categorized as extensive forested wetland and herbaceous wetland in a recently clearcut area. Tree species found in the forested wetland include *Acer rubrum*, *Nyssa sylvatica*, *Liquidambar styraciflua*, *Quercus alba*, *Quercus phellos*, and *Quercus palustris*. The shrub layer is sparse to non-existent. The herb layer includes *Carex* sp. and *Sphagnum* sp.

Several firebreaks bisect the swales. The east-west firebreak probably interferes with natural surface water flow. The wreckage of an airplane found in the northern portion of the forested wetland may once have contributed oils and gasoline to the surface and groundwater.

FIELD SURVEY METHODS

A drift fence array was erected in the forested wetland swale on 23 April 1991 and operated until 8 May 1992. The array consisted of three 7.5 m arms of aluminum flashing with a 19 liter (5 gallon) plastic bucket sunk flush with the ground at each end. The arms were arranged in an exploded spoke pattern with the interior ends of each arm being 7.5 m from the imaginary center point. Dilute formalin and water solution was used to preserve specimens. The drift fence/pitfall array was checked approximately every two weeks. All specimens were deposited in the Virginia Museum of Natural History, Martinsville, Virginia.

In addition to drift fence methods, terrestrial habitats were searched for salamanders. Some frog species were identified by their vocalizations. Specific efforts were made to determine the presence of ambystomatid salamanders during their late-winter breeding period. We identified and recorded all reptiles encountered during the field surveys. We observed basking turtles with a spotting scope or binoculars in Gambo Creek, Black Marsh, and the impoundments.

Annotated species list

1. *Ambystoma maculatum* (Shaw)

Six spotted salamanders (2 adult males, 2 adult females, 2 juveniles; VMNH 2213-2218) were collected in pitfall traps only in spring sampling periods. These specimens represent the first verified county records (Tobey, 1985). Spotted salamanders have also been observed in Caledon State Park (Hill & Pierson, 1986).

2. *Ambystoma opacum* (Gravenhorst)

Marbled salamanders were the most numerous species caught in pitfall traps. A total of 73 were caught throughout the sampling period (33 males, 38 females, 2 juveniles; VMNH 2219-2289). An adult was found under a log in the forested wetland swales area on 6 November 1991 during which time the swales were dry. Most were caught in the fall (53%) or spring (25%).

We observed a great amount of variation in dorsal pattern in this population. Of the 71 individuals, 31 displayed the normal crossbar pattern, 4 had complete longitudinal stripes, and 36 (51%) had an unusually high incidence of a combination of crossbars and partial stripes. Of 33 males, 21 had crossbars, none had stripes, and 12 had the combined pattern. Of 38 females, 10 had crossbars, 4 had stripes, and 24 had the combined pattern. Hill & Pierson (1986) observed this salamander in Caledon State Park. Our specimens provide the first vouchered county records (Tobey, 1985).

3. *Plethodon cinereus* (Green)

A total of 29 red-backed salamanders were caught (12 males, 9 females, 8 juveniles; VMNH 2292-2320) in fall and spring sampling periods. Twenty of these lacked the reddish dorsal stripe (i.e., were the "lead-backed" phase) and 9 possessed this character. Numerous records exist for this species in King George County (Tobey, 1985).

4. *Bufo americanus americanus* Holbrook

The 15 individuals recorded during this survey (VMNH 2321-2335) were all caught in the drift fence/pitfall array from late-April to late June and in September to early-October. These specimens represent the first verified county record for American toads (Tobey, 1985). They have also been observed in Caledon State Park (Hill & Pierson, 1986).

5. *Hyla chrysoscelis* Cope

This species was identified based on the presence of only Cope's gray treefrogs in the Virginia Coastal Plain (J.C. Mitchell and C.A. Pague, unpublished). A single adult female (VMNH 2336) was found in a pitfall trap in May 1992. This gray treefrog was observed in Caledon State Park by Hill & Pierson (1986). It is the first vouchered record for King George County.

6. *Pseudacris crucifer* (Wied)

Eleven adult spring peepers (VMNH 2337-2347) were found in pitfall traps in spring samples. Hill & Pierson (1986) observed this species in Caledon State Park. Our specimens provide the first verified county records.

7. *Pseudacris triseriata feriarum* (Baird)

Eight upland chorus frogs (VMNH 2348-2355) were caught in pitfall traps. All were caught in spring and late summer sampling periods. These are the first voucher specimens for King George County.

8. *Rana catesbeiana* Shaw

Two juvenile bullfrogs (VMNH 2356-2357) were caught in pitfall traps in the September-early October sampling period. This species was observed frequently in the permanent waters of upper Gambo Creek. Bullfrogs have also been observed in Caledon State Park (Hill and Pierson, 1986). Our specimens provide the first vouchers for King George County.

9. *Rana clamitans melanota* (Rafinesque)

Adult green frogs were observed at one of the impoundments, Hideaway Pond, on 21 May 1991. Hill & Pierson (1986) observed this species in Caledon State Park. The single specimen we collected (VMNH 2358) was found in a stream feeding Hidden Lake.

10. *Rana sphenocephala* Cope (in recent literature as *Rana utricularia*).

Twenty-one southern leopard frogs (VMNH 2359-2366, 2367-2379) were caught in the pitfall traps in May, June, and September-early October. Two-thirds (14) were juveniles. Adult male captures (5) slightly outnumbered females (2). Juveniles of this species were the most commonly observed frog on NSWCDL. The wetland swales may provide suitable dispersal habitat, but not during dry periods like the one in 1991. These specimens represent new county records (Tobey, 1985).

11. *Eumeces fasciatus* (Linnaeus)

Four individuals of the five-lined skink (VMNH uncatalogued) were caught in pitfall traps in spring during both 1991 and 1992 sampling periods. Three additional localities in King George County are represented by museum specimens (Mitchell, 1994).

12. *Diadophis punctatus edwardsii* (Merrem)

A single adult northern ring-neck snake (VMNH uncatalogued) was caught in June in a pitfall trap. Three vouchered localities are known for King George County (Mitchell, 1994).

13. *Nerodia sipedon sipedon* (Linnaeus)

Several northern water snakes were observed at Hideaway Pond on 21 May 1991. One verified record (Mitchell, 1994) and one additional unvouchered locality (Hill & Pierson, 1986) exist for King George County.

14. *Chelydra serpentina serpentina* (Linnaeus)

A single snapping turtle was observed in upper Gambo Creek on 22 May 1991. This observation is the first record for King George County (Mitchell, 1994).

15. *Chrysemys picta picta* (Schneider)

Eastern painted turtles were observed at Black Marsh and Hideaway Pond on 21 May 1991 and in upper Gambo Creek the following day. Other unvouchered locations known for King George County are "N of Maple Grove" (Reed, 1957) and Caledon State Park (Hill & Pierson, 1986).

16. *Kinosternon subrubrum subrubrum* (Bonnatere)

One eastern mud turtle was seen in brackish water habitat on lower Gambo Creek on 21 May 1991. This is the second recorded observation of this turtle in King George County (Hill & Pierson, 1986; Mitchell, 1994).

17. *Pseudemys rubriventris* (LeConte)

We observed red-bellied turtles in impoundments and in Gambo Creek. A previous report had listed *Pseudemys* sp. as occurring on this site (TES, Inc., 1978) that was probably this species. Hill & Pierson (1986) reported a specimen from Caledon State Park. Our observation represents the second observation for this species in King George County.

DISCUSSION

The number of amphibian and reptile species now known for King George County totals 44, including 8 salamanders, 12 anurans, 7 freshwater turtles, 6 lizards, and 11 snakes. The observations reported here for the Dalhgren Naval Weapons Laboratory and those of Hill & Pierson (1986) provide the only information on the seasonal occurrence and habitat affinities of these animals in the county. Several common species known to occur in surrounding counties remain to be verified, however, suggesting that this area promises to yield additional county records.

The goal of the survey was to search specifically for rare species (Buhlmann & Belden, 1992). Therefore, our list of amphibians and reptiles is probably incomplete because certain habitats were not studied. For example, no rare snake species were expected to occur on NSWCDL, therefore appropriate snake habitat was not thoroughly investigated. No rare amphibians or reptiles were found during the survey. However, several state-rare invertebrates were collected and deposited in the Virginia Museum of Natural History (Buhlmann & Belden, 1992).

The forested wetlands were studied extensively for their potential for tiger salamanders (*Ambystoma tigrinum*), greater sirens (*Siren lacertina*) and carpenter frogs (*Rana virgatipes*). None of these species were found and they are not believed to occur on NSWCDL. Two of the rare amphibians, the greater siren and carpenter frog, require semi-permanent water. The drought in the summer of 1991, which caused the swales to dry for much of the year, prevented any amphibian reproduction that year and precluded the discovery of these two species. In Virginia, the tiger salamander has only been found in sinkhole ponds and depressions with deep water and open canopies (Pague & Buhlmann, 1991; Buhlmann & Hobson, 1996). We believe that the swales are too shallow and too heavily canopied by trees for this species. The impoundments are stocked with game fish and are unlikely to provide appropriate habitat for these amphibian species.

Although not a rare species, the wood frog (*Rana sylvatica*) was reported as occurring on NSWCDL (TES, Inc. 1978). We encountered no evidence to suggest that a breeding population was present. The nearest known localities for this species are on Fort A.P. Hill, Caroline County (J.C. Mitchell, unpublished data) and in Stafford County (Tobey, 1985).

Management recommendations for protecting the forested swale habitat and providing a buffer habitat in the surrounding upland forest were made in a previous report (Buhlmann & Belden, 1992). Amphibians and reptiles that occupy forested wetlands often utilize adjacent uplands for dispersal, overwintering, and other functions (Buhlmann et al., 1993). Of particular conservation concern were the old ditch lines that still exert a negative impact on the natural ecology of the swales because they channel water out of the area and facilitate draining. The ditches may limit the ability of the wetlands to retain water, thereby diminishing the opportunities for amphibian reproduction. Clearcut operations at the southern end of this wetland system have already seriously jeopardized the ecological integrity of this site. Any plans to remove timber from the remaining old swamp hardwood forest would destroy the ecology of this forested wetland swale community.

In conclusion, although few rare species were found, a diversity of habitats occurred on NSWCDL. The proximity of the site to the Potomac River makes it important to migrating songbirds and waterfowl. The freshwater wetland habitats support a relatively diverse amphibian, reptile, and invertebrate fauna for this small area.

ACKNOWLEDGMENTS

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Scotch Broom, A New Host of Two Native Bugs in Virginia (Heteroptera: Alydidae)

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A new host relationship for two native heteropterans, the alydids *Alydus eurinus* (Say) and *Megalotomus quinquespinosus* (Say), was discovered during recent fieldwork in Virginia. Their association with an introduced shrub, Scotch broom (*Cytisus scoparius*; Fabaceae) is reported in this note.

The Host Plant

Scotch (or common) broom, indigenous to western Europe, is a wiry, much-branched deciduous shrub with green stems and bright yellow flowers (Everett, 1981). It has been introduced to the Pacific Northwest and to eastern North America as an ornamental and as a soil binder that retards erosion and stabilizes coastal sand dunes (Bossard & Rejmanek, 1994). In Virginia, Scotch broom has been planted since the eighteenth century, having been recommended for hedges by Thomas Jefferson (Leighton, 1976). This woody legume has become a serious weed of western rangelands, and it also displaces native plants in the Sierra Nevada foothills, hindering reforestation and increasing the fire hazard among older trees. Several Old World insects that specialize on broom have been imported and released for the biological control of this plant in the West. Such attempts, however, have not reduced its densities (Frick, 1964; Bossard & Rejmanek, 1994).

Although not considered pestiferous in the East, Scotch broom sometimes escapes from cultivation. It has become naturalized from Nova Scotia to Virginia. In the latter state it has been planted along highways, and it is locally common in the central and eastern counties (Pfeiffer, 1986; Gleason & Cronquist, 1991; Harvill et al., 1986).

The Bugs

Both true bugs are native species of the family Alydidae. Commonly termed broadheaded bugs, they range throughout most of North America: in Canada from Quebec and Ontario to British Columbia, and in the United States from Maine to Florida and west to California (Froeschner, 1988). Both *Alydus eurinus* and *Megalotomus quinquespinosus* occur statewide in Virginia (Hoffman, 1975).

These bugs belong to a mainly legume-feeding subfamily, the Alydinae. Nymphs sometimes feed on fallen seeds in the litter layer, but they more often occur on their host plants, where they feed on developing fruits and seeds. They are commonly found in weedy fields and along roadsides on clover (*Trifolium* spp.), sweet clover (*Melilotus* spp.) and other herbaceous legumes. These bugs have also been observed on flowers of New Jersey Tea (*Ceanothus americanus*; Rhamnaceae) and on vertebrate carrion (Blatchley, 1926; Yonke & Medler, 1968; Schaefer, 1972, 1980; Hoffman, 1975; Schaefer & Mitchell, 1983; Adler & Wheeler, 1984). *Alydus eurinus* feeds on soybean pods and is considered a potential pest of this crop (Wilkinson & Daugherty, 1967).

Virginia Observations

On July 4, 1995, I collected adults and mid- to late-instar nymphs of *A. eurinus* and *M. quinquespinosus* in landscape plantings of Scotch broom at five sites in Hampden-Sydney (Prince Edward Co.), including four on the campus of Hampden-Sydney College. About 15 adults of *A. eurinus* and five of *M. quinquespinosus* were observed with smaller numbers of nymphs of both species. Individuals were beaten mainly from plants bearing numerous seed pods. Nymphs of the more abundant alydid, *A. eurinus*, especially resembled the large black ants that were common on the same plants.

Other insects that had colonized this introduced shrub included both adventive and indigenous species. Old World species observed at Hampden-Sydney were the bruchid *Bruchidius ater* (Marsham) and the twobanded Japanese weevil *Callirhopalus bifasciatus* (Roelofs). Native species developing on Scotch broom included the planthoppers *Acanalonia conica* (Say), *Metcalfa pruinosa* (Say), and *Ormenoides venusta* (Melichar).

Voucher specimens of the alydids and bruchids have been deposited in the insect collections of Cornell University and the Pennsylvania Department of Agriculture.

DISCUSSION

It is hardly surprising that these heteropterans have colonized Scotch broom, considering the diversity of legumes they are known to use for reproduction. It is not unusual for two or three alydid species to feed on the same host at a particulkar locality, or even on the same plant (Schaefer, 1980). The occurrence of *A. eurinus* and *M. quinquespinosus* on this woody shrub, however, contrasts with their typical association with herbaceous hosts. In addition, the habitat ~ landscape plantings ~ differs somewhat from thatr recorded in the literature.

Alydus eurinus and *Megalotomus quinquespinosus* have undergone a host shift ~ that is, they have added the nonindigenous shrub Scotch broom to their diet. In Virginia this plant has accumulated an insect fauna that includes adventive species such as the psyllid *Arytainilla spartiophila* (Foerster) (Pfeiffer, 1986) and native species such as the two alydids. "Host shifts" and colonization of introduced plants, especially crops such as cocoa and soybean, are well known and often involve similarities in secondary chemistry. For an introduction to the litertaure on this subject, the reader may consult Futuyma & Slatkin (1983) and Strong et al. (1984).

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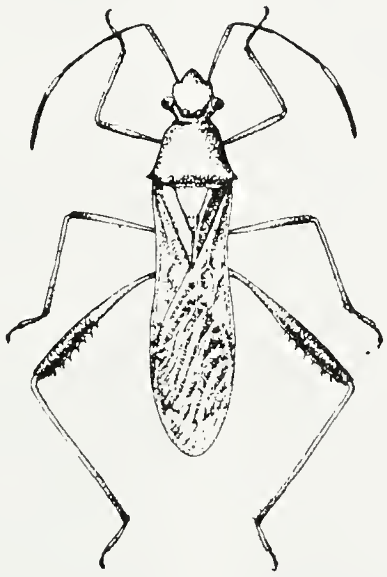

Megalotomus quinquespinosus (Say)
(from Froeschner, 1988)

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New Distributional Records for the Water Scorpion *Nepa apiculata* in the Coastal Plain of Georgia and Virginia

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The extant water scorpion (Heteroptera: Nepidae) fauna of the continental United States and Canada is comprised of 13 species in three genera (*Curicta*, *Nepa*, *Ranatra*) (Polhemus, 1988). The genus *Nepa* is monotypic in North America, with the single species, *Nepa apiculata* Uhler 1862, restricted to eastern North America. It is easily distinguished from all other North American water scorpions by its short and robust body shape (Hungerford, 1922; Sites & Polhemus, 1994).

In a recent synoptic treatment of the water scorpions of the United States and Canada, Sites & Polhemus (1994) stated that *N. apiculata* is distributed throughout the northeastern United States (and along the southern border of Canada from Quebec as far west as Manitoba) west to North Dakota and Oklahoma, and south to Georgia. The range map in Sites & Polhemus (1994) restricted the distribution of *N. apiculata* in Georgia to the extreme northwestern corner of the state, although the exact collection locality of the lone record from this state (first reported by Van Duzee, 1917) is unknown (J. T. Polhemus, pers. comm.), and our efforts to find this specimen were futile. A disjunct record for extreme southern peninsular Florida (Cape Sable, specimen in USNM) was discounted by Sites & Polhemus (1994) because this locality is widely separated from the remainder of the known range of this species, and the identity of this specimen (an early instar) is tenuous.

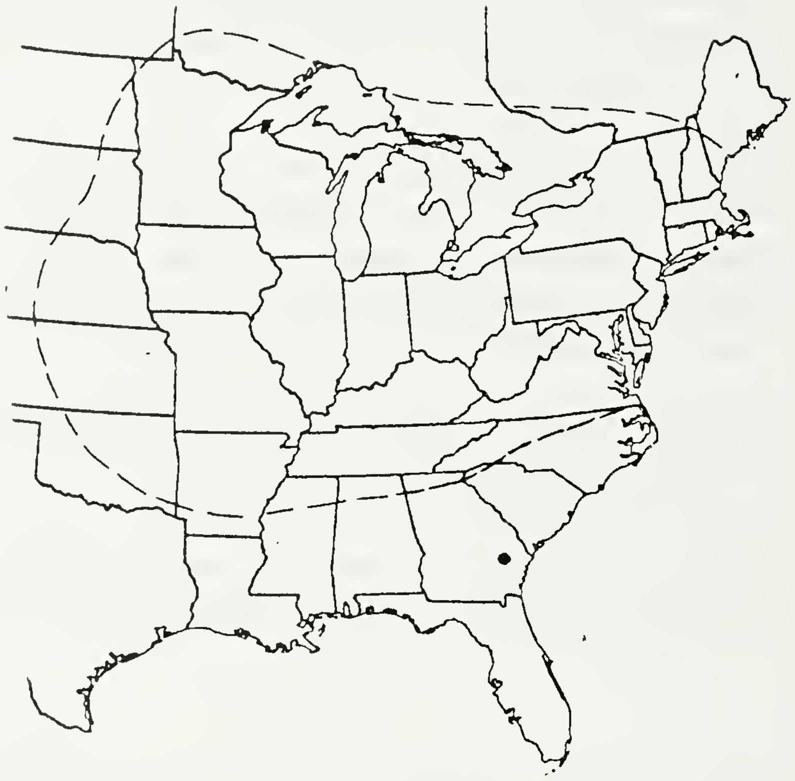

Figure 1. Distribution of *Nepa apiculata* (dashed line) as plotted by Sites & Polhemus (1994). The dot shows the general location of the two Georgia records reported in this paper.

The distribution map for *N. apiculata* in Sites & Polhemus (1994) portrays its range in the Atlantic Coastal Plain as extending south only to extreme southeastern Virginia. Bobb (1974) commented that *N. apiculata* is "decidedly rare in the Southeastern States" and stated that the only specimen known from Virginia was collected on 13 October 1973 in Gloucester County by A. G. Michael of Old Dominion University (specimen in ODU collection). Bobb (1974) was apparently unaware of the existence of three additional specimens of *N. apiculata* in the USNM that were taken in Gloucester County (presumably at the same unspecified locality) on this date (R.L. Hoffman, pers. comm.), although he did note that specimens from Patuxent and Plummer's Island, Maryland were in this collection. An additional specimen from the latter site is in the Cornell University collection (J. K. Liebherr, pers. comm.). Polhemus (1988) failed to include Virginia among the states from which *N. apiculata* had been documented, whereas the range map in Sites & Polhemus (1994) suggests that it occurs statewide. However, to our knowledge, the only other Virginia collection made prior to publication of the latter paper consists of an adult female obtained by John T. Polhemus on 15 April 1990 from a spring seep along the South Fork of Quantico Creek in Prince William Forest Park, Prince William County (J.T. Polhemus, pers. comm.; specimen in JTP personal collection).

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During the 1996 field season, we collected *N. apiculata* from two sites in the Coastal Plain of Virginia, as well as from two sites in the Coastal Plain of Georgia, the latter collections representing a significant southward extension of the known distribution for this species (Figure 1). On 30 March 1996, DJS collected an adult *N. apiculata* from within a water-soaked log in shallow water in a bald cypress (*Taxodium distichum*)-tupelo gum (*Nyssa aquatica*) swamp along the Blackwater River near the County Route 603 crossing, 9.0 km ENE Waverly, Sussex County, Virginia. SMR collected an immature specimen of *N. apiculata* on 8 August 1996 while dipnetting in aquatic vegetation along the edge of the Blackwater River in a bald cypress-tupelo gum swamp, 5.3 km NE Ivor, Southampton County, Virginia. The latter site is approximately 25 km downstream of the former locality. Both of these specimens have been deposited in the Virginia Museum of Natural History, Martinsville, Virginia.

The new *N. apiculata* records documented for Georgia (specimens deposited in the University of Georgia Museum of Natural History) are from sites in the Altamaha River drainage and are in the lower Coastal Plain. On 3 May 1996, DJS collected an adult specimen at night from a small stream which flows through bald cypress-tupelo gum swamp on the north side of the Altamaha River at Ga. Rte 121/144, 18.0 km SW Glennville, Tattnall County, Georgia. A single adult, also found at night, was taken by DJS on 20 May 1996 from leafy detritus at the edge of the Ohoopee River at Hwy. 178, 17.5 km W Glennville, Tattnall County, Georgia.

Like most nepids, *N. apiculata* prefers lentic situations. It has been reported to inhabit the muddy shorelines of spring-fed bodies of water (Sites & Polhemus, 1994), shallow, grassy slow-moving streams (Torre-Bueno, 1923), debris in streams (Hilsenhoff, 1984), acidic seepage swamps (reported as "bogs" by Ferris & Harp, 1982), sparse to dense vegetation (Torre-Bueno, 1905), and mud and debris in shallow swamps and ponds (Sanderson, 1982). It has also been found under stones in shallow water (Torre-Bueno, 1923). Hungerford (1919) described *N. apiculata* as "mud-loving", while other investigators have determined that this species is able to estivate in mud (Larimore et. al., 1959), and that females oviposit in mud (McPherson & Packauskas, 1987).

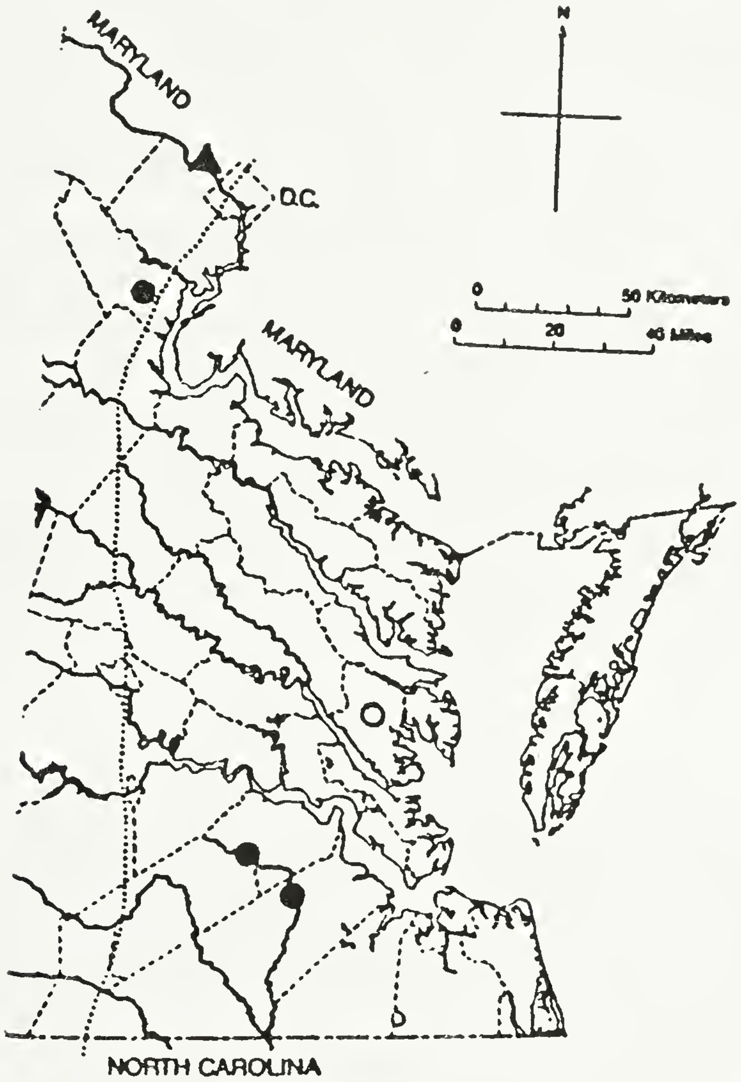

Figure 2. Distribution of *Nepa apiculata* in Virginia. The dashed line indicates the Fall Zone separating the Coastal Plain and Piedmont physiographic provinces. The open circle denotes an unspecified locality in Gloucester County and the triangle indicates the location of Plummer's Island, Maryland.

Our recent collections document only the third and fourth known sites for *N. apiculata* in Virginia (Figure 2), and reveal that the range of this water scorpion extends south in the Atlantic Coastal Plain to at least the Altamaha River, Georgia. Mud-bottomed still water habitats (floodplain swamps, oxbow sloughs) are extensive at/near each of the new collection sites for *N. apiculata* that we detail in this note. The putative rarity of *N. apiculata* in the southeastern United States (Bobb, 1974) may be attributable to the cryptic appearance and habits of this species. It is difficult to collect using traditional aquatic insect net methods, as specimens blend well with leaf litter and may feign death when captured (Sites & Polhemus, 1994). Hungerford (1919) stated that this species is "usually found in raking out mud and trash near the water's edge." It should be noted that three of our four specimens were collected by hand; the fourth was in fact taken dipnetting, but the collector was looking carefully (specifically) for *N. apiculata* specimens as he searched each net haul. Other collectors have also had success capturing this species by hand (J.T. Polhemus, pers. comm.). Given the vast amount of blackwater stream/floodplain swamp habitat present in the Coastal Plain of Virginia and southeastern Georgia, as well as in the Carolinas, it is likely that additional sites remain to be discovered for *N. apiculata* in the southeastern Coastal Plain.

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Larry Smith and Tom Rawinski of the Division of Natural Heritage assisted with collections made at the Blackwater River site in Sussex County. The Virginia Chapter of The Nature Conservancy granted access to the Ivor site. John T. Polhemus and Robert W. Sites graciously answered our inquiries and provided unpublished data. We thank the following individuals for searching the indicated museum collections on our behalf for specimens of *Nepa apiculata* from Georgia and Virginia: Richard L. Hoffman (Virginia Museum of Natural History, Blacksburg and Martinsville; USNM), James K. Liebherr (Cornell University), Eric L. Quinter (American Museum of Natural History), Norman D. Penny (California Academy of Sciences), Philip D. Perkins (Museum of Comparative Zoology, Harvard University), John E. Rawlins (Carnegie Museum of Natural History) and Cecil L. Smith (University of Georgia).

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Freshwater Fishes of an Isolated, Interdunal Freshwater Ecosystem in Northern Virginia Beach, Virginia

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The freshwater cypress-gum swamps located among dune ridges along the Atlantic coast of southeastern Virginia are a series of shallow wetlands that seldom dry completely. Most of the extant swamps are located at the northern end of the City of Virginia Beach, Virginia, in Seashore State Park and Natural Area. The park is a unique natural area and recreation site that receives several million visitors annually. The area is also unique because it supports populations of rare and geographically disjunct species (Clampitt, 1991; Henry, 1993). A small portion of the park lies along the southern shore of the Chesapeake Bay, but the majority of the park and all of the designated natural area are behind the coastal dunes and beaches.

Seashore State Park supports a series of secondary dunes, swales, interdunal cypress swamps and ponds, a forest of loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), hickories (*Carya* sp.), red maple (*Acer rubrum*), redbay (*Persea borbonia*), black gum (*Nyssa sylvatica*), and cypress (*Taxodium distichum*), and the tidal-influenced Broad Bay (Wright et al., 1990; Clampitt, 1991). It originally included the portion of Cape Henry that is now utilized by the U.S. Army as Fort Story (Adkins, 1990). A narrow strip of city residential homes lies along U.S. Rt. 60 (Atlantic Avenue) and separates the park from the Atlantic Ocean to the east. Aquatic habitats in the park other than interdunal swamps and ponds include the Chesapeake Bay, Long Creek, and Broad Bay. The latter separates the park from the highly urbanized City of Virginia Beach to the south.

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Seashore State Park is well known for its flora and fauna, having been the subject of investigations on plants (Egler, 1942; Wright et al., 1990; Clampitt, 1991), amphibians and reptiles (Werler & McCallion, 1951; Buhlmann et al., 1993; Mitchell, 1994; Buhlmann, 1995), and small mammals (Buhlmann et al., 1993). Although the fishes of the Chesapeake Bay and its tidal reaches are well known (Murdy et al., 1997), the freshwater fishes of the interdunal freshwater swamps have not been studied systematically. Jenkins & Burkhead (1994) included Seashore State Park on the distribution maps of four species, one of which was based on an unverified report. They also reported the mummichog (*Fundulus heteroclitus*) from tidal areas. In this paper we review the known freshwater fish fauna of the interdunal cypress-gum swamps in this unique ecosystem in southeastern Virginia and add an additional six species to the checklist.

Information reported herein is derived from specimens collected and observations made during 1980-1987 and in 1989. Most of the fish were collected in turtle traps made of chickenwire (Iverson, 1979), but some were obtained with dipnets and minnow traps. All specimens have been donated to the Virginia Institute of Marine Science in Gloucester Point.

A total of 10 species of freshwater fish were collected or observed in the cypress swamps of Seashore State Park during this survey. The habitat of each species consists of shallow, dark, acidic water with varying depths of decomposing organic matter on the bottom. All of the swamps sampled are located in the vicinity of the park's nature and environmental education centers in the interior of the park.

1. *Acantharchus pomotis* - Three specimens of the mud sunfish (92, 120, 162 mm standard length [SL]) were collected on 15 September 1984 and two (114 and 152 mm) on 12 September 1985. JCM and KAB observed this species frequently in turtle traps set in shallow ponds near the Nature Center and Environmental Education Center in the 1980s. A total of 13 were caught in five minnow traps on 22 December 1989. Jenkins and Burkhead (1994) illustrated a record for Seashore State Park.

2. *Amia calva* - JCM observed an adult bowfin in a large and deep, interdunal, cypress-gum swamp on 19 September 1984. Jenkins & Burkhead (1994) included a record for Seashore State Park.

3. *Aphredoderus sayanus* - A total of 14 pirate perch were collected on 15 September 1984. The series averaged 65.1 ± 19.3 mm SL (36-95 mm). New record.

4. *Centrarchus macropterus* - Fliers were the most common fish encountered in the interdunal cypress swamps, many of which were caught in turtle traps. Two (42 and 50 mm SL) were collected on 15 September 1984. Four were caught in five minnow traps on 2 December 1989 and 42 were caught on 22 December 1989. New record.

5. *Chologaster cornuta* - A single specimen of the swampfish (27 mm SL) was collected on 14 August 1984 in the interdunal pond adjacent to the nature center by Bonnie J. Larson. Its occurrence in Seashore State Park noted by Jenkins & Burkhead (1994) is based on a personal communication about this specimen from C.A. Pague. KAB observed an adult in an interdunal swamp adjacent to the access road on 14 November 1989.

6. *Enneacanthus obesus* - Two banded sunfish (69 and 80 mm sl) were collected on 15 September 1984. New record.

7. *Esox niger* - One chain pickerel measuring 265 mm SL was caught on 15 September 1984. New record.

8. *Gambusia holbrooki* - This native species was reported for Seashore State Park by Jenkins & Burkhead (1994).

9. *Lepomis gulosus* - Two warmouth (101 and 144 mm SL) were caught on 12 May 1987. New record.

10. *Umbra pygmaea* - Eastern mudminnows were collected on 16 August 1980 (34 mm SL) and 15 September 1984 (52, 57, 58, 63 mm SL). Several were observed during 4 July - 5 December 1989. New record.

The wetlands supporting these fish populations may be relics of a much more extensive system of interdunal swales and freshwater swamps and ponds that existed during the Pleistocene (Oats & Coch, 1973). Rising sea levels since the last glaciation eliminated many of these wetlands in southeastern Virginia and northeastern North Carolina. The populations and genetic lineages of the native species in Seashore State Park are probably at least as old as the Pleistocene.

Jenkins & Burkhead (1994) pointed out that four of the ten species recorded here (chain pickerel, mudminnow, pirate perch, and swampfish) seem localized in the area. Their distribution patterns may be artifacts of collecting effort and alteration of wetlands by human activities. Nevertheless, the freshwater fish fauna of Seashore State Park more closely resembles that of the Great Dismal Swamp than the fish in the freshwater ponds among the dunes in Nags Head Woods on the Outer Banks of North Carolina. Norman et al. (in press) lists 32 species (including six introduced species) for Lake Drummond and adjacent drainage ditches in the Great Dismal Swamp National Wildlife Refuge. These include all of the species now verified for Seashore State Park. The freshwater ponds in Nags Head Woods contain seven species, only one of which (*Gambusia holbrooki*) also occurs in the swamps of Seashore State Park. In contrast, the herpetofaunas of Seashore State Park (Buhlmann et al., 1993; J.C. Mitchell and C.A. Pague, unpublished), Great Dismal Swamp (Mitchell et al., in press), and Nags Head Woods (Braswell, 1988) are all similar.

The freshwater fish fauna in the cypress-gum swamps of Seashore State Park appeared to be stable in the 1980s. Our observations throughout that period suggested no changes in abundance. Management of this vertebrate assemblage in the interdunal ponds could be accomplished by allowing the dune-swamp ecosystem to remain intact and unaltered, and by preventing introductions of fish and other vertebrates derived from other locations.

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Shorter Contributions

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JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) STRANDED BY COLD IN THE CHESAPEAKE BAY -- Reports of sea turtles stranded because of cold water temperatures are not uncommon for coastal Atlantic waters north of the Carolinas (Morreale et al., 1992; Shoop & Kenney, 1992). In the Chesapeake Bay of Virginia, USA, stranded sea turtles have been reported for all months outside of the normal activity season (May-October) when juveniles of at least four species (loggerhead [*Caretta caretta*], green turtle [*Chelonia mydas*], hawksbill [*Eretmochelys imbricata*], Kemp's ridley [*Lepidochelys kempii*]) enter the Bay to forage (Keinath et al., 1987; Mitchell, 1994). Sea turtles usually enter and leave the Chesapeake Bay when the water temperature rises above or falls below 18° C (Musick, 1988). Barco & Pitchford (1990) reported that four live *C. caretta* and one live *L. kempii* were found stranded on beaches along the southern end of the Chesapeake Bay and on the Atlantic beach of the City of Virginia Beach, Virginia, between 8 and 14 December 1989. They also noted that five additional loggerheads were found after this period. Although several individuals of *C. mydas* have been recorded for the Chesapeake Bay (Keinath et al., 1987; Keinath & Musick, 1991), reports of stranded green turtles due to cold temperatures in this estuary have not been published.

The earliest *Chelonia mydas* recorded in the waters of the Chesapeake Bay during winter months was a juvenile (National Museum of Natural History, USNM 51212) found on 25 January 1893 at the mouth of the Bay by J.A. Bully. This record was first reported by Reed (1957). The latest record is of a juvenile found on 14 December 1995 on the eastern shore of the Chesapeake Bay about 0.8 km south of Kiptopeke State Park, Northampton County, Virginia by G. Williamson and P. Williamson. The turtle measured 33.9 cm straightline carapace length and 27.9 cm plastron length. It was dead when found but exhibited no obvious signs of injury or decomposition. Water temperatures in the mouth of the Chesapeake Bay, the mouth of the James River, and southwest of Cape Charles on 12 December 1995 were 5.5-6.8°C (n = 6 each depth) at 1 m, 5.7-6.8°C at 5 m, 5.3-7.3°C at 10 m, and 6.1-9.8°C at 15 m. These temperatures, well below those marking annual entry and exit to and from the Bay, and the late dates, suggest that the deaths of the juvenile reported here and the one reported by Reed (1957) were related to cold torpor. If these are rare occurrences, then the losses to the *Chelonia mydas* population off the North American coast may not be severe. However, the continued decline of this species causes even these rare instances of natural mortality to grow in importance.

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THE LEAF BEETLE *PSEUDOLAMPSIS GUTTATA* (LECONTE) IN VIRGINIA (CHRYSOMELIDAE: ALTICINAE). -- A blacklight trap placed by Steven M. Roble and the author beside a private access road continuing Co. Rt. 666, 2 km east of Claresville, Greensville Co., Virginia, collected a large number of insects during its overnight operation on 7-8 August 1996. Upon being sorted for preparation at the Virginia Museum of Natural History, the accumulation was noted to include dozens of specimens of a small and very colorful alticine chrysomelid not represented in the museum's collection. On the basis of enlarged metafemora, apically spherical 5th tarsomere of the rear legs, and densely hispid elytra, the species was identified to the genus *Distigmoptera* with the recent manual of northeastern beetles by Downie & Arnett (1996). However, the specimens did not conform to the generic diagnosis in lacking both mid-elytral depressions and long coarse dorsal setae, nor did it "key out" to any of the six species treated. Several individuals sent to the Department of Entomology, National Museum of Natural History were identified by Steven Lingefelter, Research Entomologist with the USDA Systematic Entomology Laboratory, to be *Pseudolampsis guttata* (LeConte), a beetle with a distinctly Lower Austral distribution

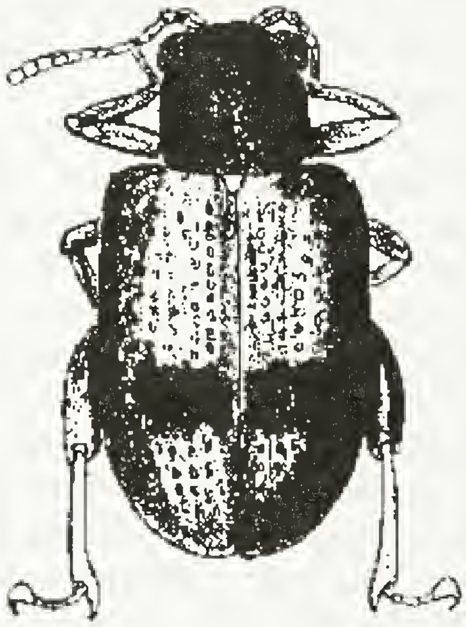
The collection site is beside an extensive permanent marsh in the Meherrin River floodplain. Subsequent sorting of backlogged samples at VMNH produced three additional specimens of *guttata*, taken by random sweeping of low vegetation near the Meherrin River on 19 August 1994 (VMNH survey party). This site is about 1 km east of the blacklight station, with which it seemed to have few vegetational facies in common.

Originally described from Louisiana, *P. guttata* was not listed for North Carolina in either of the insect lists compiled by Brimley (1938) or Wray (1967), and no specimens are represented in the insect collection at North Carolina State University. It is recorded by Kirk (1969) for Florence and Sumter counties, South Carolina, with the notation "Extremely rare, but common locally." These are apparently the northernmost published localities for the species. The known range was reviewed by Balsbaugh (1969), who established that the beetle extends from South Carolina to Argentina.

Dr. Lingafelter kindly provided a list of the *guttata* material in the USNM collection. Most (16 specimens) are from Alachua and Highlands counties, Florida, but several are from

Morgan, Louisiana (7), and Marion, Somerset County, Maryland (1). This last locality, near the midlength of the Delmarva Peninsula, extends the known range of the species some 210 km northeast of the Greensville County site and 530 km (320 miles) from Florence, S. C.

Kirk specified black lighting as the source of his South Carolina material, and several USNM series from Maryland, Florida, and Louisiana carry a similar notation, suggesting this to be an optimal way to obtain the species. However, since both VMNH and DCR-DNH personnel have employed blacklight techniques at many sites in southeastern Virginia during the past six years without encountering this beetle elsewhere, some environmental factor is an obviously important determinant affecting its local distribution. A series of 10 beetles from Alachua County, Florida (USNM), are noted to have been reared on *Azolla caroliniana*, which suggests that light traps placed near *Azolla* "stands" have a good chance to obtain this "Extremely rare, but common locally" species elsewhere in eastern Virginia.



Pseudolampsis guttata is an elegant little beetle, with a maximum length of about 3.0 mm. The thorax is notably narrow (about as wide as a single elytron), and the entire body surface is invested in very fine dense pubescence. With low magnification the body appears nearly black, except that the pubescence reflects light as either white or gold, depending on the angle of illumination. In most specimens the midelytral regions tend to be somewhat reddish or maroon. Legs and antennae are light brown to yellowish. Species of *Distigmoptera* are similar in size and proportions, but are much "shaggier" with long coarse hairs dorsally, and each elytron is marked with a circular pit near the midlength.

I am indebted to Dr. Roble for his ongoing and fruitful collaboration with VMNH inventory work, to Robert L. Blinn for access to the NCSU collection, and to Dr. Lingafelter for making the identification and providing collection data from specimens in the USNM collection.

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Miscellanea

Book Review

A Guide to Endangered and Threatened Species in Virginia, coordinated by Karen Terwilliger and John R. Tate, abridgment by Susan L. Woodward. 1995. The McDonald & Woodward Publishing Co., Blacksburg, VA. x + 220 pages. Softcover. $14.95 + shipping ($3.00). Available from The McDonald & Woodward Publishing Co., 6414 Riverland Dr., Fort Pierce, FL 34982.

I figure it's never too early to instill a conservation ethic in a child, so I have been searching my library for just the right kind of natural history books to read to little Peter. He definitely likes pretty pictures, so this rules out most of my floras. *Virginia's Endangered Species* (McDonald and Woodward Publishing Co., 1991) has great photographs, but it's a large book and difficult to manage with a baby on one's lap. Thankfully, Karen Terwilliger, John R. Tate, and Susan L. Woodward have compiled *A Guide to Endangered and Threatened Species in Virginia*, an abridged and updated version of the aforementioned award-winning volume. As a smaller, less expensive book with superb color photographs, the *Guide* suits us just fine as we spend quality time with the Appalachian Monkeyface, the Barking Treefrog, and Addison's Leatherflower. In all, the *Guide* contains 140 one-page accounts of plants and animals officially recognized or proposed as threatened or endangered on state and federal lists. The featured plants, arthropods, mollusks, fishes, amphibians, reptiles, birds, and mammals show us biological diversity in rare form and color. Three plants, three freshwater mussels, one isopod, and one bird have been added to the *Guide* to reflect recent discoveries and status changes since 1991. Also, individual species accounts now exist for the marine mammals.

The species accounts are concise and well written, but I was very disappointed that an opportunity was missed to clarify the often confusing and important distinction between federal and state legal status designations. On page 40, for example, red ink is used to highlight the fact that Northern Joint-vetch is "Endangered (proposed)." The reader does not know if this is in reference to a federal or a state status designation, and would not know that the species is federally threatened unless he or she happened to scrutinize Appendix III on page 200. As a proposed state endangered species, Northern Joint-vetch is not yet afforded legal protection under the Virginia Endangered Plant and Insect Species Act, but is protected under the federal Endangered Species Act, as amended.

Virginia distribution maps are provided for all species except sea turtles and marine mammals, which is understandable. But where is an index map to the counties and independent cities? It is unfortunate that no such index is provided in the *Guide*. There is no explanation for the use of open circles to illustrate the distribution of the Mountain Lion. Referring back to *Virginia Endangered Species*, I am left to assume that the open circles denote unsubstantiated records of the Mountain Lion, which in my opinion don't belong in either book. An open circle is also used to show the distribution of the Shortnose Sturgeon. This open circle represents a confirmed record of the species from the Potomac River, but the actual collection site is Washington, DC. Confusion could have been avoided by eliminating this particular distribution map.

The book's introduction focuses on agencies responsible for endangered species conservation in Virginia, enabling legislation, and the many ways citizens can promote endangered species conservation. In the discussion of the Endangered Plant and Insect Species Act on pages 3 and 4, candidate species are described, but no mention is made of proposed species. It would have been helpful to clarify the subtle distinction between these terms, as defined in the Act, so that readers would know exactly what a proposed endangered species is.

I was especially pleased that the book included "The Nature of Virginia", an excellent overview of the Commonwealth's natural environments and biota originally written by Susan L. Woodward and Richard L. Hoffman for *Virginia's Endangered Species*. Each major taxonomic section of the book begins with a discussion of the ecology, identification, and unique conservation issues facing the particular group of species.

Appendix III has serious problems. The heading reads, "Species Listed as Endangered or Threatened in Virginia." But because several of the species are not yet officially listed, the heading is misleading. As an example, five of the six insects mentioned are "Threatened (proposed)" in their respective species accounts. Perhaps a unique status code should have been applied to the proposed species to indicate such. Chaffseed (*Schwalbea americana*), federally endangered since 1992, and Seabeach Pigweed (*Amaranthus pumilus*), federally threatened since 1993, should have been included in this tabulation. Several omissions and errors exist among the legal status codes. The code of SER for the Brook Floater is undefined and is probably a typographical error. The code of FE should have been applied to Michaux's Sumac and Peters Mountain Mallow, and the code FT removed from Ginseng. Also, according to my inquiries, the Prairie White Fringed Orchid has not yet been officially proposed as a state endangered species, and is as yet only a candidate species. Lastly, *Fimbristylis perpusilla* is misspelled, and readers might wonder why the Cumberland Bean and Pink Mucket, listed in this appendix, are not given full-page descriptions in the main body of the book. Incidentally, *Amaranthus pumilus* is misspelled in Appendix V.

The *Guide* nevertheless is a beautiful, informative, and important book. It should appeal to the widest possible audience, in part because the use of technical terms is limited and literature citations - which might distract some readers - have been removed from the text. I do question, however, the decision to supplant metric units of measurement with English units. Many school children are familiar with the metric system, and I feel that an element of precision may have been compromised by converting the body length measurement of the Swamp Skimmer, for instance, from 43-49 mm to "about $1^{7/8}$ to 2 inches."

Although this book falls somewhat short of its intended purpose, I do recommend it to all lovers of nature. And, I can attest to the fact that the book offers parents and children an exciting alternative to traditional bedtime story reading! A take-home message of the book is that Virginia citizens can play an active role in endangered species conservation. You'll be glad to own this book, and to know that royalties from your purchase went to the Virginia Nongame and Endangered Wildlife Program.

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Obituary

David A. Breil

Dr. David A. Breil, Professor of Biology at Longwood College, passed away suddenly on March 3, 1997. He was doing what he liked to do on that day, he was teaching his morning class at the college. A memorial service was held at the Farmville United Methodist Church on March 6, which was attended by students, colleagues from the Natural Sciences Department and throughout the college, and many friends. Dave is survived by his wife, Phyllis S. Breil, and six children.

Dave was born in Massachusetts, received his B.S. and M.S. degrees from the University of Massachusetts, and earned his Ph.D. in Botany from Florida State University. He had been on the Longwood faculty since 1968, serving as advisor to many biology majors over the years, Delegate to the Longwood Council, Chairman of the Landscape Planning Committee, and President of the Longwood/Hampden-Sydney Sigma Xi Club. He was a member of the American Bryological and Lichenological Association, the Virginia Academy of Science, the Southern Appalachian Botanical Club, and Sigma Xi. He taught in the Environmental Science graduate program at Longwood, he taught at Mountain Lake Biological Station, and he directed wildflower walks at Wintergreen on occasion. He is cited in a popular botany text for his research on mosses used as nest building materials by native birds in the Appalachian Mountains of Virginia. He most recently published "Liverworts and hornworts of the Virginia Piedmont" in ***Banisteria*** (1996, number 8).

Dave was a member of the Virginia Natural History Society, with a gift membership. I gave him the gift, or rather Hampden-Sydney did, as a thank you because he came to my botany class last spring to teach our students about mosses and liverworts. Dave had made this trip of seven miles to my college from Longwood in Farmville every other year for the past eight. It was on these days that I too learned more about these small plants and watched my students be inspired to go collecting and identifying the bryophytes introduced to them by Dave. I am grateful for his talents as a teacher, his scholarship, and his friendship. I will remember him every time I teach about the cellular detail of sphagnum and the "leaf" arrangements of mosses and liverworts.

Anne Lund
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Reports

1. Minutes of the Executive Committee Meeting of the Virginia Natural History Society, December 16, 1996, at Hampden-Sydney College.

In attendance: Norm Fashing, Richard Hoffman, Michael Kosztarab, Barry Knisley, Anne Lund, Joe Mitchell, Dick Neves, and Tom Rawinski. The meeting was called to order by President Knisley.

The Secretary/Treasurer reported that the treasury contained $5,821 at the end of November. Membership was 146, including libraries and organizations. It was suggested that libraries and public and private colleges should be sent a letter again encouraging membership. A brochure describing the Society was discussed, and Rawinski and Mitchell were to pursue this matter.

The editors reported that ***Banisteria*** number 8 was being printed. They noted that there were some delays, some postal, in getting the pages to the printer. They were pleased to mention the lead article on bryophytes of the Virginia Piedmont and that several manuscripts were left over to start the next number. The journal will contain an announcement of the joint VNHS/VAS meeting in Blacksburg in May 1997.

Hoffman would include information about the VNHS in the next available magazine published by the Virginia Natural History Museum.

Election of new officers was discussed. Rawinski will become President for 1997-1998. Vice President and Secretary/Treasurer were on the ballot unopposed. Several names were put forward for the vacant Councilor position, and those people were to be contacted to determine if they would allow their names to be placed on the ballot. Knisley would prepare the ballot.

Richard Hoffman would be accepted as a Life Member of the society. He received a thank you from the Society for the balance of the contribution he made originally for the publication of the first issue of ***Banisteria***.

Mitchell and others discussed possible symposia sponsored by the VNHS. There was some discussion of a joint sponsorship of a symposium with the National Forest Service, including the possibility of publishing the proceedings from such a symposium.

A call will be made to members to propose invited speakers for the Natural History and Biodiversity section of the VAS (the VNHS meeting venue) for their annual meeting in Blacksburg.

Anne Lund
Secretary/Treasurer

Announcements

1. Forthcoming meetings

The Society for the History of Natural History - 27-29 April 1997, University of Virginia, Charlottesville. This is their 11th international conference. This society publishes Archives of Natural History three time a year. Membership is open to anyone interested in the history of botany, geology, and zoology. Contact The Secretary, Society for the History of Natural History, c/o The Natural History Museum, Cromwell Road, London SW7 5BD England.

Virginia Herpetological Society - 9-11 May 1997. Southeastern Virginia. Assemble at the Super 8 Motel in the City of Suffolk. The field trip will be to the U.S. Naval Facility at the southern end of the City of Chesapeake. This area is part of the historical Dismal Swamp and supports a rich herpetofauna. Excursions will be led by Dr. Alan Savitzky to canebrake rattlesnake research sites and by others on general herpetofaunal forays. For information, contact Michael S. Hayslett, Secretary VHS, 923 Euclid Ave., Lynchburg, VA 24501 or Michael Pinder, Department of Game and Inland Fisheries, 2206 S. Main St., Suite C, Blacksburg, VA 24060 (540-552-6992).

VNHS - 22 May 1996. VPI&SU, Blacksburg, VA, with the Virginia Academy of Science. Persons interested in presenting a paper at this meeting should contact the VNHS secretary.

2. Forthcoming Symposia

The George Washington and Jefferson National Forest (now combined administratively) is planning to organize a one-day symposium on the history, physical environment, and natural history of the Big Levels sinkhole pond area of Augusta County. This area is rich in human and natural history and has been the target of numerous biotic investigations. The area is well known for its northern and Coastal Plain disjunct populations and for several unique species. Dr. Daniel Downey will host the meeting at James Madison University, Harrisonburg, VA. The date has not yet been determined, but is planned for early 1998. Plans include the publication of the papers given at this symposium in an issue of ***Banisteria***. For additional information, contact Dr. Joseph C. Mitchell (Co-editor).

Instructions for Contributors

Banisteria accepts manuscripts of one to several pages in length that contribute to the public and scientific knowledge of the natural history of Virginia. This publication is intended to be an outlet for the kind of information that is useful but would not be accepted in the mainstream journals. Information found in field notebooks and files that never made it into scientific journals is especially important. **Banisteria's** focus is classical and therefore slanted toward organismal biology.

Manuscripts should be sent in duplicate to one of the Co-editors, who will assign them to an appropriate section editor, who in turn will seek one or sometimes two reviews. Reviews of manuscripts written by a section editor will be handled by a different editor. Authors should retain both the original typescript and figures until final acceptance for publication. Photocopies are adequate for review purposes.

Manuscripts must be written on one side of standard size paper (21.5 x 28 cm) using double spacing throughout. Words should not be hyphenated. Use single spacing between sentences.

Manuscripts should be arranged in the following order: **title, author's name, author's address, text, acknowledgments, literature cited, tables, figure legends, figures**. Long manuscripts should have standard sections, e.g., Materials and Methods, Results, and Discussion. Short manuscripts (<4-6 pages) should not have these sections. All pages should be numbered, including tables. The title should be concise but informative. It, and the author's name and address should be centered at the top of the first page. The text should begin on the first page beneath the author's address. Use good judgment on arrangement of sections when other than the standard approach is necessary. Use underlines for species' scientific names.

References: Use the following as a guide. Spell out journal names in full.

Journal article with 1 author
Scott, D. 1986. Notes on the eastern hognose snake, *Heterodon platyrhinos* Latreille (Squamata: Colubridae), in a Virginia barrier island. Brimleyana 12:51-55.

Journal with 2 authors
Tilley, S. C., & D. W. Tinkle. 1968. A reinterpretation of the reproductive cycle and demography of the salamander *Desmognathusochrophaeus*. Copeia 1968:299-303.

Journal with 3+ authors
Funderburg, J. B., P. Hertz, & W. M. Kerfoot. 1974. A range extension for the carpenter frog, *Rana virgatipes* Cope, in the Chesapeake Bay region. Bulletin Maryland Herpetological Society 10:77-79.

Book:
Harris, L. D. 1984. The Fragmented Forest. University of Chicago Press, Chicago, Illinois. 211 pp.

Chapter in a book
Gentry, A. H. 1986. Endemism in tropical versus temperate plant communities. Pp. 153-181, *in*: M. Soule (ed.), Conservation Biology. Sinauer Associates, Inc., Sunderland, Massachusetts.

Report:
The Nature Conservancy. 1975. The preservation of natural diversity: A survey and recommendations. Report to the U.S. Dept. of Interior, Washington, D.C., 189 pp. (include report series and number if present).

Tables: Each table should be typed on a separate sheet of paper. A legend for each table should follow the number and must be on the same page as the table. Ruled, horizontal lines should be avoided except at the top and bottom of the table.

Figures: Black and white line drawings are acceptable for publication. They should be less than 21.5 x 28 cm in size. The back of each figure should be labeled with the author's name.

Photographs: Banisteria will accept high contrast black and white photographs. Submit at least 5x7 inch photos and mount them if possible.

Abbreviations: The following common abbreviations are accepted in **Banisteria**: n (sample size), no. (number), SVL (snout-vent length; define on first usage); yr (years), mo (months), wk (weeks), h (hours), min (minutes), s (seconds), P (probability), df (degrees of freedom), SD and SE (standard deviation and standard error), ns (not significant), l (liter), g (gram), mm (millimeter), and C (degrees Celsius). Do not abbreviate "male" and "female", or dates, or undefined terms.

Electronic transfer of manuscripts: Once a manuscript has been accepted for publication, one paper copy and an electronic copy on a 3.5 inch diskette should be sent to R.L. Hoffman at the Virginia Museum of Natural History. If possible, use IBM-compatible systems with Word Perfect or Microsoft Word.

Reprints: Reprints are not provided. However, authors and their institutions may photocopy their articles for personal use and for exchange purposes.

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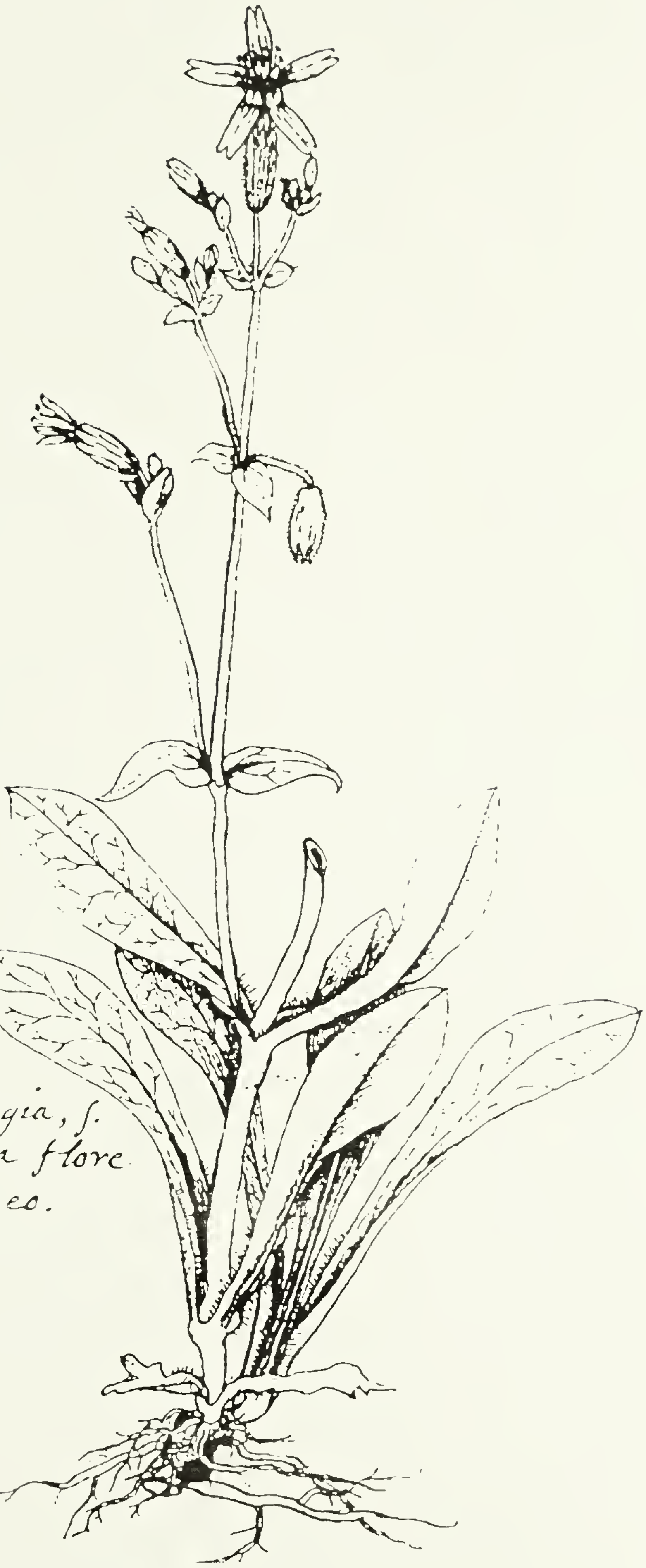

*Muscipula Regia, s.
Lychnis viscosa flore
amplo coccineo.*